OREGON STATE UNIVERSITY EXTENSION SERVICE

Enhancing Urban and Suburban Landscapes to Protect Pollinators

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Photo: Lynn Ketchum, © Oregon State University

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Photo: Chris LaBelle, © Oregon State University

Gardens in the backyards and landscaped areas of cities and towns provide a variety of ecological niches for pollinating insects.

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Introduction

A great variety of pollinating insects make their homes in urban landscapes of the Pacific Northwest. These include hundreds of different species of bees, butterflies, moths and flies. In fact, the gardens and backyards of urban environments can be as rich in insect life as wildland outside the city limits.

Towns, cities and suburbs can be highly successful environments for insect pollinators because they consist of small plots of land that are managed in slightly different ways. Landscapes change from backyard to backyard, and across the multiple ways people use cities — from community gardens to parks, landscaped commercial areas and golf courses. This diversity of land use leads to numerous ecological niches, allowing urban areas to support a host of different insect pollinators.

The benefits associated with these small plots can be greatly enhanced by actively managing them for pollinating insects.

Having many different kinds of insect pollinators is good for those who appreciate these beautiful insects, and also for anyone growing fruit, nuts or vegetables in and around urban areas. These visiting insects can increase yield. Why? Because many common food plants benefit from pollinator visits. Pollinators deposit more pollen onto female reproductive organs, resulting in more fruit, and more fruit of higher quality.

Urban landscapes that support pollinators also benefit from the growing number of people keeping honey bees or mason bees in cities as a hobby.

Finally, landscapes that support a broad array of insect pollinators contribute to preserving the region's plant and insect biodiversity, ensuring robust and resilient ecosystems.

This manual is for homeowners, gardeners, landscape professionals, arborists, nurseries, municipal governments, planners and volunteer groups, such as Master Gardeners™ and Master Beekeepers. It focuses on developing landscapes that attract and protect insect pollinators and enhance their urban habitats, and contribute to the overall beauty and environmental health of our cities.

Photo: Maxar Technologies, Metro, State of Oregon, USGS Survey

The variety of landscapes in a city such as Portland attract many different pollinating insects.

This guide has been adapted from *Protecting and Enhancing Pollinators in Urban Landscapes*, Michigan State University Extension Bulletin E3314. While this publication focuses on insect pollinators, many of these plant selections and management strategies aid other beneficial insects, as well as pollinators that are not insects, such as hummingbirds.

There are two key elements to protecting pollinators and enhancing urban landscapes for pollinators:

- Creating pollinator habitat.
- Keeping plants healthy without exposing pollinating insects to pesticides that are toxic to them.

Pollinator habitat

This publication focuses on creating pollinator habitats in Oregon, Washington and western Idaho. A large component of creating pollinator habitat centers on selecting pollinator plants suitable for the specific growing conditions found across the region. The Pacific Northwest has a wide array of growing conditions. Plants that grow well in Klamath Falls may not be suitable in Seattle. This manual provides plant selections that are suitable for locations across the Pacific Northwest, but emphasizes the area west of the Cascade Mountains.

Plant selection is more than determining which plants grow where. Creating pollinator habitat requires integrating elements of landscape design in a way that benefits a wide array of pollinating insects across the entire season, while also serving the needs of the public. A well-planned pollinator habitat should support pollinators while increasing the accessibility of nutritious food in a vegetable garden, enhancing the landscape at golf courses or reducing maintenance costs for public parks.

While some gardeners and landscapers may focus on native plants, others may be looking for low-maintenance plants that are hardy in a variety of growing conditions. This manual provides several pollinator garden designs that can be used as a starting point for creating pollinator habitat across a broad range of urban landscaping and gardening situations.

Reducing pesticide exposure

The second purpose of this manual is to provide guidance on how to keep these plants healthy in a way that minimizes impacts on pollinators.

In 2013 and 2014, a series of bumble bee die-offs in Oregon associated with the use of insecticides on shade trees spurred legislation aimed at educating pesticide applicators.

Incidents of large-scale bee die-offs are rare. For the past 30 years or more, many tree-care professionals, landscapers, urban foresters and informed property owners have managed destructive insects by minimizing pesticide use and focusing on a diversity of approaches to keep pests under control. These approaches include proper plant selection and care, and the use of predators and parasites that naturally keep pests under control. These approaches are part of a pest management strategy known as Integrated Pest Management, or IPM.

In Pacific Northwest states, landscape professionals must attend educational classes on pesticide safety as part of licensing requirements.

Are insecticides the same as pesticides?

A pesticide is a substance or mixture of substances intended to destroy, repel or prevent a pest. Although you may hear the terms pesticide and insecticide used interchangeably, they are not necessarily the same thing.

An **insecticide** is a type of pesticide that works against insects.

An **herbicide** is a type of pesticide that works against weeds.

A **fungicide** is a type of pesticide that works against plant pathogens.

Minimizing pesticide use via IPM protects water resources from pesticide runoff; minimizes the exposure of people, pets and wildlife to pesticides; and provides stable, long-term pest control instead of the boom-and-bust pest cycles associated with the use of broad-spectrum pesticides.

IPM strategies can reduce or eliminate pesticide use. In some instances, however, invasive pests present unique challenges. Invasive pests often originate from Europe and Asia. Once in the Pacific Northwest, they can have destructive impacts on North American plants and on horticultural and agricultural industries.

Invasive insects can be destructive because our North American plants may lack natural defenses or resistance to pests from Europe or Asia. In addition, invasive pest populations may build rapidly because our landscapes lack the specific predators and parasitoids that control them in their native habitat.

Azalea lacebug (*Stephanitis pyrioides*), brown marmorated stink bug (*Halyomorpha halys*), spotted-wing drosophila (*Drosophila suzukii*) and ash whitefly (*Siphoninus phillyreae*) are some of the most destructive invasive insects in the Pacific Northwest.

Homeowners, business property owners and cities sometimes choose to use a pesticide to protect lindens, roses, azaleas and rhododendrons, fruit trees, ash, birch, and other trees and shrubs susceptible to invasive insects. However, when insecticides are used for invasive pests, they may impact pollinators and other beneficial insects and mites — including predators and parasitoids that keep plant pests under control.

This publication provides best management practices for protecting popular plants in gardens and urban landscapes from invasive pests while minimizing the impact on pollinators and beneficial insects.

Note: When using any pesticide, read and follow the label instructions and be sure the product is registered for use in your state.

5 BEES COMMON TO THE PACIFIC NORTHWEST

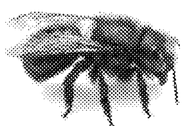
There are an estimated 800 species of bees in the Pacific Northwest. Bees common to urban landscapes include:

Honey bee
Family Apidae, *Apis mellifera*, 1 species

Honey bee
- Highly social — thousands of nestmates and a queen.
- Only bee that makes honey.
- Females carry pollen in spoon-like structures on rear leg (corbicula).
- The only bee active November–January.

Bumble bee
Family Apidae, *Bombus* spp., 25 species

Bumble bee
- Solitary phase — mated queens winter and start colonies in the spring.
- Social phase — 50–500 workers and a queen, annual nests.
- Females carry pollen in spoon-like structures on rear leg (corbicula).
- Active January–November (depending on the species).



Mason bee
Family Megachilidae, *Osmia* spp., 75 species

Mason bee
- Solitary.
- Builds nests above ground, repurposing narrow cavities.
- Females carry pollen on hairs on abdomen (scopa).
- Active April–September.

Metallic sweat bee
Family Halictidae, *Agopostemon* spp., 5 species

Metallic sweat bee
- Solitary/communal.
- Digs nests in the ground.
- Females carry pollen on hairs on rear legs (scopa).
- Active April–September.

Small carpenter bee
Family Apidae, *Ceratina* spp., 5 species

Small carpenter bee
- Solitary/communal.
- Lives in pithy dead twigs.
- Females carry pollen on hairs on rear legs (scopa).
- Active April–September.

Photos: Oregon Department of Agriculture

PART 1

Pollinators in urban landscapes

Pollinators of the Pacific Northwest

In most agricultural situations, honey bees — which are native to Europe, central Asia, the Middle East and Africa — are the dominant pollinator. This is because honey bees can be raised in hives, which can easily be brought in and out of farm fields. Most honey bee colonies are kept outside city limits and are managed by commercial beekeepers. However, a growing number of small-scale beekeepers maintain colonies in urban landscapes. Bees can fly well over a mile to search for pollen and nectar. Colonies located within three miles of a given site can be affected by the pesticides used and the quality of the habitat at that site.

The managed bees in the Pacific Northwest go beyond honey bees. Beginning in the 1950s, alfalfa seed growers in the region began developing nesting beds for the solitary native alkali bee, *Nomia melanderi*. These remarkable bees remain the only managed ground-nesting bee in the world. By the 1960s, these same growers also learned how to manage an introduced solitary twig-nesting bee, the alfalfa leafcutting bee, *Megachile rotundata*, on a large scale. Combined, these two solitary species power the state's alfalfa seed sector.

More recently, cherry and pear growers have been learning to manage a native solitary twig-nesting bee, the blue orchard bee, *Osmia lignaria*. Blue orchard bees have also proven to be a terrific species for backyard and community gardens. In recent years, Master Gardeners™ and some Soil and Water Conservation districts have been active in training people to care for and propagate these bees.

Photo: Lynn Ketchum, © Oregon State University

Pollinators benefit agriculture and ecosystems

Most plants need pollination to form fruit and reproduce. While some plants are wind-pollinated, many require assistance from insects, hummingbirds or other animals. Three groups of plants particularly important to our economy and our environment benefit from Pacific Northwest pollinators:

1. **Food crops:** Many high-value food crops depend on pollinators — mostly bees — for high-quality and abundant harvests. These include berries, orchard fruit, melons, squash and other cucurbits.
2. **Seed crops:** Our region produces a variety of high-value seed crops, including clover seed, alfalfa seed and a broad variety of vegetable seeds. Pollinators — particularly bees — are essential to sufficient harvests for seed crop growers.
3. **Native plants:** Outside of cropping systems, many of the native plants in our region rely on pollinators to reproduce and persist in the wild.

In addition to managed bees, over 800 species of bees are native to the Pacific Northwest (Figure 1, page 5), along with flies, beetles, butterflies, wasps and other insects that pollinate plants. A variety of native bees and flies pollinate most home and community garden crops.

Some native bee species "buzz pollinate" by vibrating flowers, which allows pollen to be shaken from the inner surface of enclosed tubes known as poricidal anthers. These bees grasp the flowers and rapidly contract flight muscles in a manner that dislodges the pollen and allows it to shake free from the anther. This helps blueberries, tomatoes and other crops that have poricidal anthers and require buzz pollination.

Bumble bees buzz pollinate. They are the most effective pollinators of crops such as blueberries, tomatoes and eggplant.

Many other bees can buzz pollinate, but not honey bees. In plants with poricidal anthers, honey bee pollination ranges from adequate effectiveness — in the case of some blueberry cultivars — to inadequate effectiveness, in the case of tomatoes.

The best pollination occurs when a diversity of pollinating insects with different body shapes and foraging behaviors is active at different times of the year.

Factors that threaten pollinator health

Pacific Northwest pollinators face some of the same pressures as those in other states. Most researchers agree that a combination of factors is causing declines in bee and pollinator populations. These include the spread of parasites and diseases among pollinator populations, loss of habitat or flowers that provide pollen and nectar, and pesticide exposure. Each of these negatively affects bees, but there is also evidence that the combination of stresses is especially harmful (Figure 2, page 7).

Parasites and diseases

Honey bee colonies have been beset by significant new parasite and disease pressures over the last few decades. This has led to poor colony survival and substantially increased labor on the part of beekeepers. Parasites and diseases are also implicated in lower returns of alfalfa leafcutter bees and the shrinking range of some native bee species, notably the Western bumble bee (*Bombus occidentalis*) in western Oregon. However, not much is known about disease pressure and prevalence in most Northwest native bee species.

Pesticide exposure

Pollinators are susceptible to pesticides used in agriculture, forestry, mosquito control and landscape management. Different types of pesticides impact pollinators in specific ways.

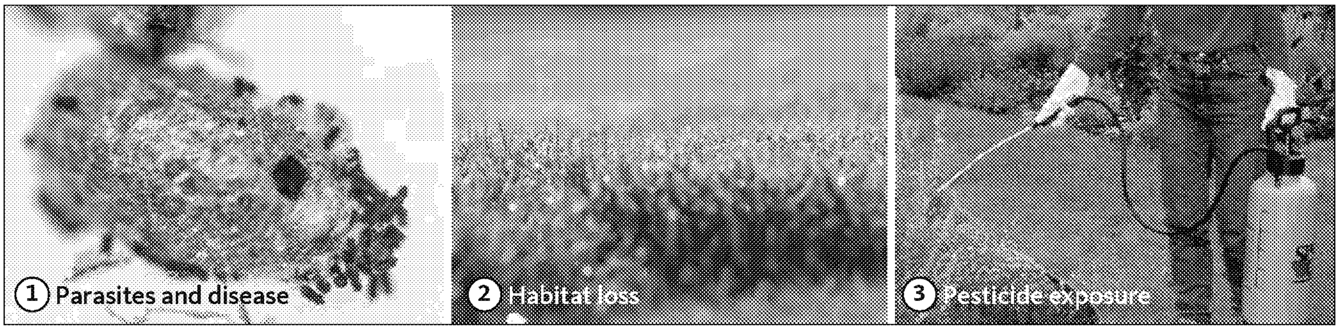
Insecticides target insect pests and are often toxic to pollinating insects.

Herbicides manage weedy plant species. While few herbicides are toxic to insect pollinators, many kill plants that provide nectar and pollen for bees. Consequently, herbicides can have an indirect effect on pollinators by reducing their forage.

Fungicides are products used to control some plant diseases. Like herbicides, most fungicides are not directly toxic to pollinating insects, but some interfere with microbial processes used by pollinators to digest food or fend off diseases. In addition, some fungicides interfere with the natural capacity of pollinating insects to detoxify insecticides. This combination of fungicides and otherwise relatively nontoxic insecticides becomes toxic to pollinators.

Pollinators are exposed to pesticides in a variety of ways (Figure 3, page 7). In some cases, the flowers that pollinating insects forage on have pesticide residue on the flower petals and leaves, and they pick up small amounts of pesticides each time they contact the plant. These chemicals can kill pollinating insects directly or

Figure 2. Causes of pollinator decline

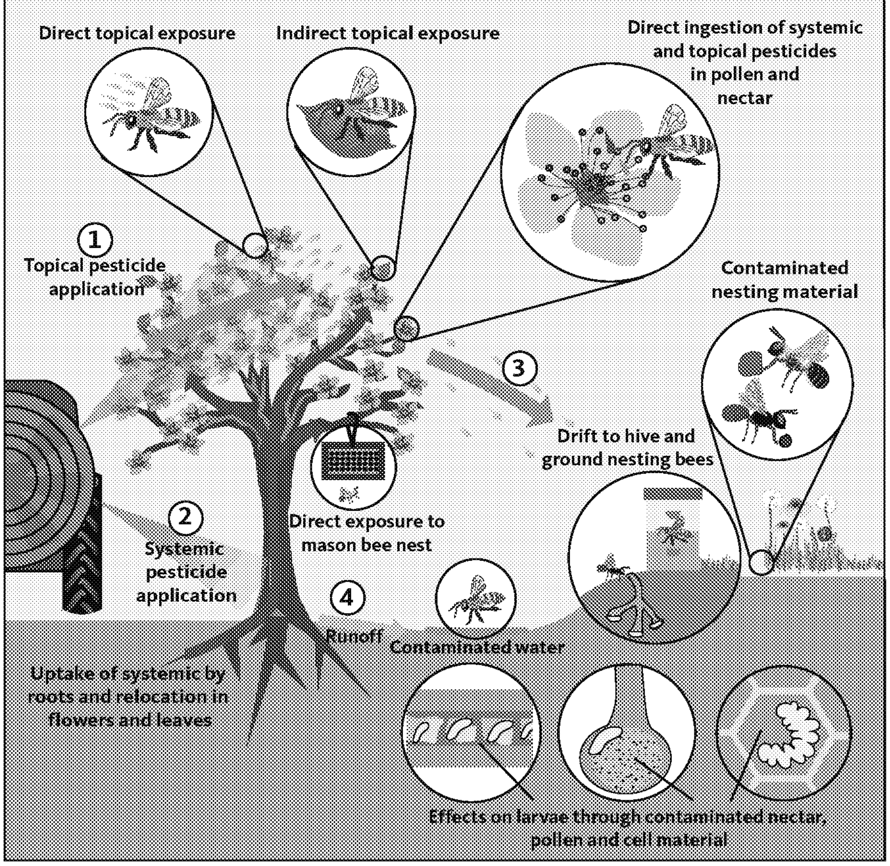


Photos: © Oregon State University

There is no one cause of pollinator decline. Decline is the product of three main factors: (1) the spread of parasites and diseases among pollinator populations, such as these mason bee cocoons infest by a wasp parasite, (2) the loss of habitat or flowers that provide pollen and nectar — such as when wildland is converted to lawn — and (3) pesticide exposure. Climate change is expected to impact all these factors.

Figure 3. Routes of exposure

Pollinators, like bees, can be exposed to pesticides in multiple ways: (1) direct contact with pesticides or pesticide residues that remain active on foliage and flowers, (2) in nectar and pollen for systemic pesticide treatments that are drawn up through a plant's vascular system, (3) pesticide drift into areas where bees are foraging, nesting or gathering nesting material, and (4) pesticide runoff that contaminates water that bees forage on or the nesting beds of ground-nesting bees.



Graphic: Iris Kormann, © Oregon State University

impair their ability to navigate, reproduce or develop.

Some pesticides are highly toxic to bees, while others are relatively safe. Toxicity depends on the specific chemical and the insect's exposure to it. Scientists don't yet know the effect of long-term exposure of pollinators to low doses that the insect may encounter over its lifetime. This accumulation of exposure is also known as chronic toxicity. We also don't know much about the direct toxic effects, or acute toxicity, of pesticides on pollinating insects outside of honey bees, alfalfa leafcutting bees and some bumble bees.

The incidents of bumble bee poisoning in Oregon drew attention to exposure risks associated with pesticide residue on treated plants and the use of systemic insecticides (Figure 3, exposure route 2). Systemic insecticides move through the plants' phloem and are important for the control of sucking insects like aphids. Unlike products that impact pollinators that contact treated flowers (Figure 3, exposure route 1), these products are present in the pollen and nectar that the flower produces. Consequently, the poisonings occurred from systemic insecticides applied to the soil and bark well before the trees began to flower. These incidents prompted both pesticide regulators and educators to rethink how these products may pose a risk to bees.

Scientists have intensively studied neonicotinoids, the group of systemic pesticides responsible for these incidents, to determine their impact on bees. Neonicotinoids are widely used on field crops, and homeowners use them in yards and gardens.

Neonicotinoids are a class of insecticide that acts on the insect's nervous system. They are more toxic to insects than mammals, and are safer for humans to use than many other classes of insecticides. Neonicotinoids are toxic to insects through direct contact or by ingestion.

The most widely used neonicotinoids — imidacloprid, thiamethoxam, clothianidin and dinotefuran — are all highly toxic to bees. The labels of products containing these active ingredients have bee-warning boxes with important instructions for limiting bee exposure that must be followed. Others, like acetamiprid, are far less toxic to bees (see "Better pesticides to use around pollinators," page 37).

Foraging bees can also expose developing larvae and other nestmates to pesticides by collecting contaminated pollen or nectar and bringing it back to their nest or colony. Small amounts of pesticides in nectar and pollen can harm both native and honey bees. When a neonicotinoid is applied as a soil drench (a dilute solution poured around the plant base), it may persist for a year or more, especially in woody plants. It can also move into weeds or flowers growing in the drenched soil. If some of the insecticide moves into pollen or nectar, it may not kill bees directly, but it can act as a stressor to affect larval growth, navigation, susceptibility to diseases or survival. Moreover, ground nesting bees may be harmed if soil applications are made in the vicinity of nesting beds (Figure 3, exposure route 3).

It is important to note however, that research from Washington State University indicates that neonicotinoid pesticides do not accumulate in honey bee hives as might be expected by their frequent use. As part of a three-year survey, researchers found that colonies in fewer than 5% of apiaries located in nonagricultural areas, which includes urban and rural areas, had accumulated residues of these pesticides. Moreover, levels that they detected in hives were well below concentrations that harm bees. This example goes to show that the toxicity of a product may not necessarily reflect its risk. See "What increases the risks pesticides pose to pollinators?," page 32.

Although much attention has been directed to neonicotinoid insecticides and some newer systemic pesticides, research on honey bees has indicated that no single pesticide class is associated with negative impacts on honey bee health. Rather, threats to bee health arise from a combination of many products that may accumulate in colonies over time or directly impact foraging bees. Since bees forage through a wide range of landscapes, they may be exposed to a complex mixture of many different chemicals. Urban land managers concerned with pollinator health should reduce or eliminate pesticide use, particularly around bee-attractive plants during bloom. As we describe below, the key step to reducing, or even eliminating, pesticide use in urban areas entails selecting plants that

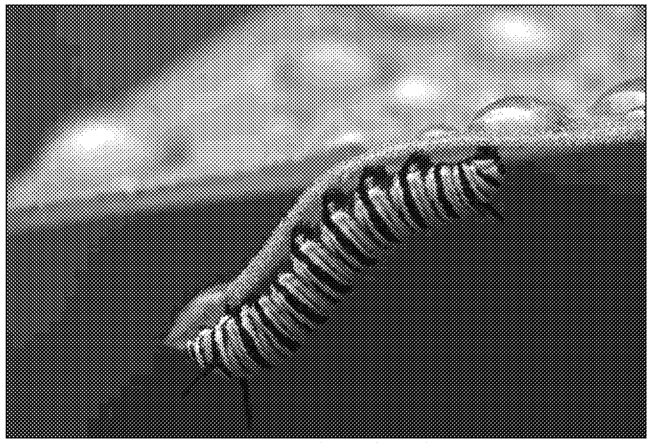


Photo: Blue Ridge Kitties, CC BY-NC-SA 2.0

Figure 4. Many caterpillars, like this Monarch larvae, depend on native plants for food.

are not prone to pests and diseases. See "Selecting, planting and care of trees and shrubs to avoid the need for pesticides," page 18.

Habitat loss and nutrition

Habitat loss is strongly associated with the decline of a number of insect pollinator species. These include the monarch butterflies (*Danaus plexippus*), as well as three Pacific Northwest butterflies that are now federally listed as either endangered or threatened — Fender's blue butterfly (*Icaricia icarioides fender*), Taylor's checkerspot (*Euphydryas editha taylori*) and Oregon silverspot (*Speyeria zerene hippolyta*). Although there are no federally listed bees in the Pacific Northwest, some species have experienced dramatic range reductions, in particular, the western bumble bee (see above).

Pollinators depend on flowers for food. For all pollinators, nectar provides carbohydrates, while pollen can serve as their source of protein, fat, vitamins and minerals. Flowerless landscapes such as mowed lawns with strict weed control and heavily paved areas of cities contain little to no food for pollinating insects. Flowerbeds in gardens or commercial landscapes provide nectar and pollen resources for pollinators, and they can offer plants that bloom at critical points in the life cycle of some pollinating species. Good nutrition mitigates stresses associated with diseases, parasites and pesticides, which in turn increases pollinator survival and reproduction.

Butterflies, moths and flies differ from bees, in that the immature larvae do not feed on collected pollen, but rather on another food source. Butterfly and moth larvae, which are known as caterpillars, feed directly on plant stems and leaves. Many caterpillars depend on native plant species for successful development into adult butterflies and moths. The larvae of pollinating flies include predators and parasitoids that attack other insects, or carrion feeders that feed on dead or decaying organic materials.

In addition to food, pollinating insects have specific requirements for shelter. All pollinating insects have vulnerable developmental stages, such as pupation or wintering. They frequently seek cover in woody debris, leaf litter or tall grass. For bees, this takes on an additional dimension, as they raise their young in nests. Bee nests can be long, slender tunnels dug into the ground. They can be pithy stems, or abandoned beetle burrows in dead wood. Bumble bees often establish nests in abandoned mouse nests, or sometimes in a small crack under a garden shed, a mulch pile or a birdhouse. Creating habitat for pollinators means making sure there are sufficient spots in the landscape where pollinating insects can nest and rest.

Uncertainty

Although we know considerably more about the factors influencing pollinator health now compared to 10 years ago, there remains a high level of uncertainty around how all these factors interact to influence pollinator populations on the ground. Pollinators have evolved in complex communities composed of a variety of native plants visited by multiple competing pollinator species. We do not have a clear picture of how these pollinator plant networks operate or how to replicate them in urban areas. When it comes to the bees, we do not even have a complete inventory of bees living in the region.

While we know which pesticides are toxic to pollinators, it is not clear how much of the pesticides are reaching pollinators, or how their toxicity changes when combined with other pesticides. We lack tools to measure key variables at meaningful spatial scales — the distribution of native bee species across the Pacific Northwest, disease levels in managed bee stocks, actual pesticide exposure to bees, etc. We also often lack specific, research-based recommendations for urban spaces that can be implemented in a cost-effective manner.

Climate change is expected to increase uncertainty. Pollinator species vary in their tolerance to temperature extremes, and climate change is expected to impact the timing and intensity of bloom that pollinators depend on.

Protecting and enhancing urban landscapes is still an imperfect science, and recommendations will inevitably change as more research is conducted. This guide is meant to outline general principles that reflect our current understanding of how to enhance pollinator habitats in urban and suburban settings.

Creating and maintaining pollinator-friendly habitat

The key to creating pollinator habitat is to provide pollinating insects with a place to raise their young and a food source. These resources need to be present over the course of an individual's or a colony's life span. Since the food and shelter requirements of different pollinating insects can be specific to groups or even species of pollinators, knowing how to help all of them can be complicated. In many cases, we do not even know the specific requirements of a given species.

Consequently, the best overall strategy is to encourage the broadest array of pollinators by growing many different types of flowering plants that produce nectar and pollen. Such a strategy will incorporate many flowering annuals, perennials, shrubs and trees into your urban landscape, so there is always something blooming, from early spring through autumn. In addition to nectar- and pollen-bearing flowers, include plants that butterfly and moth caterpillars feed on, plus nesting spots for bees, and places for various pollinating insects to overwinter.

Pollinator habitat can be built into different features of existing urban landscapes. Consider how much lawn you maintain and whether some of it could be converted into a perennial bed with pollinator flowers. If lawn is important to the function of your landscape, you could consider several options to make the area more pollinator-friendly. For example, you could plant early-season bulbs in your lawn that finish flowering early in the spring, before turf grasses grow tall and need to be mowed. You could consider installing an eco-lawn that incorporates low-growing clovers and other flowing plants like daisies, dwarf California poppies, alyssum, creeping thyme and others. Or, you could increase your tolerance for clover, ground ivy, black medic, vetch, dandelions and other flowering lawn weeds that provide resources for pollinators.

If you live in an apartment, focus on plants that grow well in containers. A golf course superintendent might consider a pollinator meadow in out-of-play areas, seeded with plants that fit the aesthetics of golfers and are readily regenerated through standard mowing practices. Urban parks managers should think about shade trees and shrubs that provide a large number of flowers, particularly in the spring when pollinators emerge from hibernation, or diapause.

Whatever your situation, start by converting a small area to pollinator habitat. Pay attention to what works and what attracts the broadest range of pollinators. In other words, learn from the experience before advancing.

"Just start small," Al Shay, a landscape instructor at Oregon State University, said in Episode 28 of OSU's PolliNation podcast, available at *extension.oregonstate.edu/podcast/pollination-podcast/28-al-shay-urban-landscapes-people-pollinators*. "Instead of doing 43,560 square feet, do 200 or 400 square feet, and really take a peek at what is going on."

Figure 5. Flower shape

Photos: Andony Melathopoulos, © Oregon State University

Black-eyed Susan (*Rudbeckia hirta*, left), planted beside Russian sage (*Perovskia atriplicifolia*). These flowers attract different bees. Short-tongued bees, such as sweat bees, visit composite black-eyed Susan flowers. Long-tongued bees, such as bumble bees, honey bees and leafcutting bees, visit the more complicated and deeper Russian sage flowers.

Creating pollinator habitat: 10 principles for ensuring a good start

Seek a diversity of flower shapes and plant families

1 Pollinators compete for nectar and pollen resources produced by flowers. Over eons, plants have evolved strategies to use this competition to ensure more pollen is moved to plants of the same species, enabling seed and fruit formation. As a result, flowers have adapted their shapes to meet the specific behavior and morphology of a restricted group of pollinators. In turn, these pollinators deliver more pollen between plants of the same species, a situation know as floral fidelity.

Research from Eastern Oregon confirms that different bee species are attracted to flowers with specific shapes. Bees with longer tongues and larger body sizes, such as bumble bees and mason bees, were found visiting complex flowers with bilateral symmetry and longer flower length, such as vetches and clovers. Short-tongued bees, which includes most of the major bee families including mining bees and sweat bees, preferred easily accessible composite flowers made up of multiple simpler flowers, such as sunflower.

You can witness this sorting of bees in any garden. For example, if you visit a bed of black-eyed Susan (*Rudbeckia hirta*), planted beside Russian sage (*Perovskia atriplicifolia*) you will notice all the short-tongued bees on the composite black-eyed Susan and long-tongued bees on the more complicated and deeper Russian sage flowers (Figure 5). There are very few pollinator species in urban areas that will only visit a specific species of plant for nectar and pollen; most will use a range of plants.

Flowers are only part of the picture. Butterflies and moths, for example, require plants for their immature caterpillars to feed on. These plants, called host plants, are often native to a region. Host plants west of the Cascades include many of the low, creeping groundcover plants you would find in a shrub-heath habitat, such as kinnikinnick (*Arctostaphylos uva-ursi*) and manzanitas (*Arctostaphylos* spp.). Native oaks and willows are also excellent host plants for many caterpillar species.

Being a plant pollinator "matchmaker," however, is not only logistically complicated — think of how many pollinator species an urban landscape attracts — but also impossible, since scientists do not know the plant preferences of most pollinators. Consequently, a good rule of thumb is to ensure high plant diversity as a means of serving the widest number of pollinator species.

TAKEAWAY: To ensure that a broad array of pollinators benefit from plants in urban landscapes, include plants across different plant families with a broad range of flower types. These include plants with disk flowers, urn-shaped flowers and flowers with bilateral symmetry.

Ensure continuous flowering

2 Pollinators need access to flowers across the course of their life span — or in the case of social bees, across the life span of the colony.

Some insect pollinators, such as butterflies and moths, can move across the landscape looking for new patches of flowers coming into bloom when the bloom in their immediate area fades. But searching for patches takes up energy. For nest-building pollinators such as bees, foraging is restricted to a short distance from their nest. If bloom stops during the period when bees are building nests, the result could be reduced reproduction.

In many parts of the Pacific Northwest, few plants bloom in late summer and early fall. Having pollinator-attractive plants in bloom during this critical time can be a tremendous boost to migrating butterflies and other late-season pollinators preparing for winter.

Early spring is also an important time. If there is a gap in the availability of flowering plants while early pollinators such as mason bees are emerging, mating and building new nests, few will survive to create the next generation.

TAKEAWAY: Plan your urban landscape to ensure a continuous sequence of bloom from early spring to fall.

Include native plants, not just horticultural plants

3 Many native pollinators prefer to forage from native plants. Although horticultural or non-native garden ornamentals such as magnolias, dogwoods, hybrid tea roses, dahlias, tulips and hydrangeas offer profuse blooms, many are not widely visited by a broad array of native pollinators. The odds of attracting many different kinds of pollinating insects can improve when landscapers and gardeners choose native plants.

While many exotic plants are attractive to pollinators, native plants offer additional advantages. Research conducted by the Oregon State University Garden Ecology Lab suggests that exotic plants that are highly attractive to bees— such as catnip (*Nepeta cataria*) or oregano (*Origanum vulgare*) — may not attract the diversity of bees that native plants such as blue field gilia (*Gilia capitata*) or Douglas' aster (*Aster subspicatus*) attract.

As with all principles, however, there are many exceptions. For example, native bumble bees thrive on fields of horticultural clovers grown commercially for seed in western Oregon because these clovers are close in shape to the native milk vetches and clovers these bees evolved with. Similarly, research from Eastern Oregon shows that weedy non-native species of plants can be equally attractive to the same kinds of native bees as native plants, provided they are from the same plant family and share similar flower shape as their native plant relatives.

Native plants can sometimes be difficult to find in retail garden centers, and they may not fit the aesthetic palette of all gardens. Mixing native plants with horticultural plants can help retain flexibility around landscape design while maximizing benefits to pollinators.

TAKEAWAY: Incorporate native plants into your landscape to improve the odds of attracting the broadest range of insect pollinators.

Figure 6. Double-petaled flowers

Photos: Neil Bell, © Oregon State University

Single-petaled varieties of a flower like Rose of Sharon (*Hibiscus syriacus*, bottom photo) offer nectar and pollen resources that double-petaled varieties (top) do not.

Plant single-flowered varieties that produce pollen and nectar

4 Plant breeders have selectively bred ornamental plants to suit the aesthetic preferences of people across the ages. But, as Emily Erickson of Penn State University noted on Episode 78 of the PolliNation podcast, this process of selection "could alter the utility of these plants to bees, either in a negative way or positive way." (Listen to the episode at *extension.oregonstate.edu/podcast/pollination-podcast/78-emily-erickson-breeding-attractiveness-garden-plants.)*

Two paths for selection that have uniformly come at the expense of pollinators are doubling the number of petals per flower, and eliminating pollen or nectar production. Doubling the number of petals has resulted in varieties that are stunningly full during bloom (Figure 6). But the doubling is frequently accomplished by mutations that cause some or all of the stamens (the pollen-producing organs of the flower) to be replaced

Photos: Lynn Ketchum, © Oregon State University

Figure 7. Select open-pollinated varieties of sunflowers to ensure pollen production for bees.

with petals, resulting in no pollen for bees. Moreover, the extra petals interfere with nectar production, or make it difficult for pollinators to reach the nectaries, which are the floral organs that produce nectar and which are typically located deep at the base of the flower.

In efforts to reduce reproduction and excessive pollen shedding for cut flowers, some varieties have been selected for mutations that render the plant male-sterile. Pollen-free plants are bred so only female traits are present on the flower; pollen is the product of male sex-organs. Consequently, a few varieties of otherwise excellent pollen plants for bees, such as sunflowers, have virtually no pollen production.

To ensure pollen production, select open-pollinated varieties (Figure 7). While many varieties resulting from hybrid crosses can produce pollen, most pollen-free varieties are the product of hybrid crosses. Open-pollinated native sunflowers, or varieties like Autumn Beauty, Lemon Queen or Black Russian, produce copious amounts of late-season pollen.

TAKEAWAY: Although double-petal and male-sterile varieties have a place in gardens and other ornamental landscapes, people who are interested in pollinator conservation need to expand their plant palette beyond these showy plants.

Plant fewer, larger blocks of flowers

5 Native bees, in particular, are attracted to larger blocks of flowers compared to smaller, disconnected clumps. Research from Michigan State University showed increases in the abundance and diversity of native bees at 30 square feet and continued improvement up to a patch size of 300 square feet. The benefits of larger patches can be particularly pronounced for smaller bees, which generally have very small foraging ranges (150–300 feet) from their nest. If patches are too small, these bees may be unable to travel far enough to find sufficient pollen and nectar to successfully reproduce.

Home gardeners with smaller yards can adopt the spirit of this principle by planting pollinator-friendly plants in clusters of multiple plants, rather than growing a single pollinator-friendly plant.

This principle is particularly useful for people who have the ability to plan, plant and manage larger blocks of land, such as golf course superintendents, landscapers working in commercial spaces or planners working in urban parks.

TAKEAWAY: If you have the space, group pollinator plants in blocks of 30 square feet or larger.

Include bulbs, shrubs and trees

6 Fitting enough flowers into a small urban landscape can be challenging. Bulbs, shrubs and trees can provide excellent solutions for packing pollen and nectar resources into constrained landscape designs.

One way to do this is to plant flowering bulbs attractive to pollinators, such as crocuses, in lawns. This provides a flush of early season nectar and pollen before mowing season begins. Research at the University of Arkansas showed good establishment of such bulbs by creating holes in existing sod, setting the bulb and covering it with loose soil. Bulbs could also be set before installing new sod.

Trees and shrubs are able to pack a lot of flowers in a small area. Some of the best pollinator plants in the region are shrubs or trees. These include fruit trees, particularly cherries and apples, which have abundant and nutritious pollen and high concentrations of nectar (Table 1, page 13). However, some are susceptible to diseases (Table 2, page 19). It is also important to note that many fruit trees can harbor pests that can be a source of infestation to surrounding orchards. In Washington, homeowners in the Yakima Valley, Wenatchee Valley and Columbia Basin can be cited if they do not manage their trees for these pests and may be billed for the cost of tree removal or a pest company spraying the tree.

Native shrubs and trees are also exceptional, including vine maple (*Acer circinatum*), willows (*Salix* spp.), flowering currant (*Ribes sanguineum*), western ninebark (*Physocarpus capitatus*), oceanspray (*Holodiscus discolor*), manzanita (*Arctostaphylos* spp.), chokecherry (*Prunus virginiana*) and Oregon grape (*Mahonia aquifolium*).

Exotic shrubs that provide months of nectar and pollen resources include rosemary (*Rosmarinus officinalis*), with bloom extending from late winter into spring, and Russian sage (*Perovskia atriplicifolia*).

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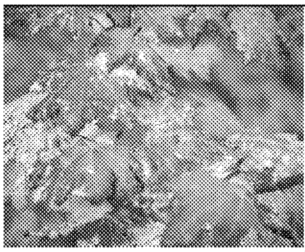
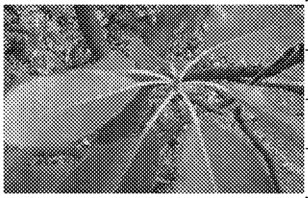
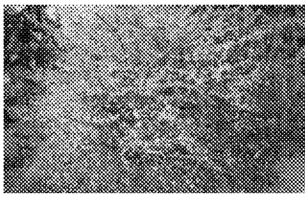
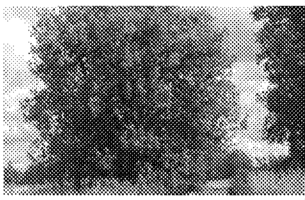
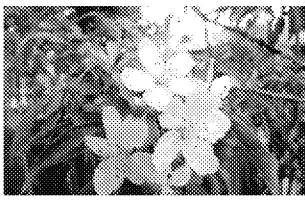
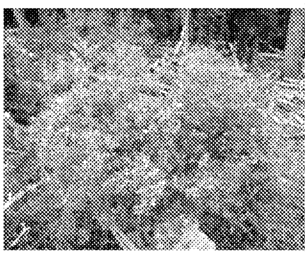
Table 1. Trees attractive to pollinators



Common name	Genus/species	Spring flowering	Summer flowering	Northwest native
Vine maple	*Acer circinatum*	✓		✓
Douglas maple	*Acer glabrum* var. *Douglasii*	✓		✓
Bigleaf maple	*Acer macrophyllum*	✓		✓
Red maple	*Acer rubrum*	✓		
Western serviceberry	*Amelanchier alnifolia*, spp.	✓		✓
Downy serviceberry	*Amelanchier arborea*	✓		
Madrone	*Arbutus menziesii*, spp.	✓		✓
Northern catalpa	*Catalpa speciosa*		✓	
Western redbud	*Cercis occidentalis*	✓		✓
Yellowwood	*Cladrastis kentukea*	✓		
Cornelian cherry	*Cornus mas*	✓		
Pacific dogwood	*Cornus nuttallii*	✓		✓
Cockspur hawthorne	*Crataegus crus-galli*	✓		
Ash	*Fraxinus* spp.	✓		Some
Golden raintree	*Koelreuteria reticulata*		✓	
Tulip tree	*Liriodendron tulipifera*	✓	✓	
Apple	*Malus domestica*	✓		
Flowering crabapple	*Malus floribunda*	✓		
Oregon crabapple	*Malus fusca*	✓		✓
Tupelo	*Nyssa sylvatica*	✓		
Sourwood	*Oxydendrum arboreum*		✓	
Cherry, peach, plum, etc.	*Prunus* spp.	✓		
Oregon white oak	*Quercus garryana*	✓		✓
Cascara	*Rhamnus (Frangula) purshiana*	✓		✓
Black locust	*Robinia pseudoacacia*	✓		
Scouler's willow	*Salix scouleriana*	✓		✓
Sitka willow	*Salix sitchensis*	✓		✓
Willows	*Salix* spp.	✓		Some
American basswood	*Tilia americana*		✓	
Linden	*Tilia cordata*		✓	

PHOTO CREDITS
Vine maple: U.S. Forest Service; Madrone: Oregon Caves;
Cornelian cherry: Neil Bell; Oregon ash: Tom Brandt, CC BY 2.0;
flowering crabapple: Signe Danler, © Oregon State University
cherry: Stephen Ward, © Oregon State University;
Scouler's willow: Dave Powell, USDA Forest Service, Bugwood.org

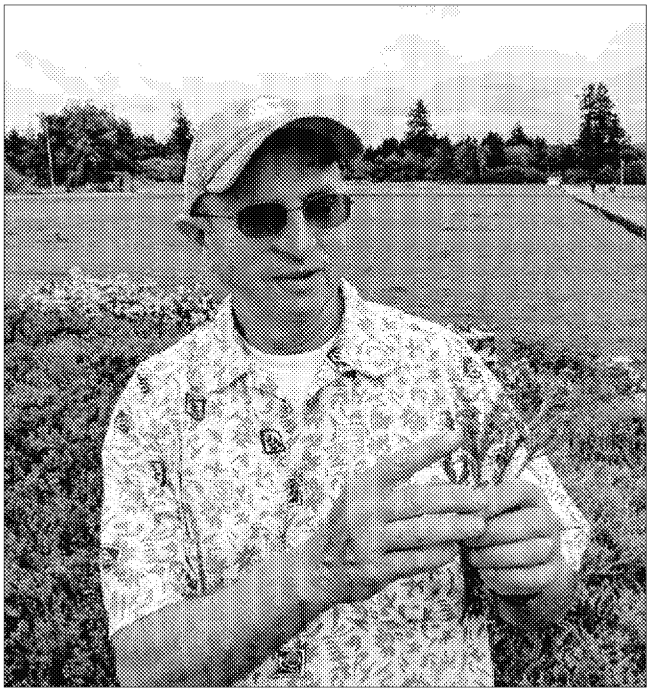


Photo: Andony Melathopoulos, © Oregon State University

Figure 8. Mixing early and late-blooming varieties of the same shrub can be an effective strategy for providing forage for bees at key times of the year. Washington State University faculty member Kim Patten holds up heather shrubs that bloom in late summer, interplanted with heather that blooms in early spring. Coastal cranberry growers use this strategy to boost bumble bee populations. Listen to Patten's interview on the PolliNation podcast at *https://beav.es/4BY*.

Bloom time can also be extended by including early and late-blooming cultivars of the same shrub. A survey from the Washington and Oregon coast, for example, indicated that mixing early blooming heathers (for example, *Erica x darleyensis* or *Erica carnea*, which bloom February–March) with late-blooming heathers (*Erica cinerea*, which blooms July–September) provides resources for bumble bee colonies at their most vulnerable time — when queens are founding colonies and when they are completing reproduction (Figure 9, page 15).

An excellent water-wise shrub for western Oregon is California lilac (*Ceanothus* spp.), which comes in three sizes: ground-cover (*C. gloriosus*, for example), a medium-sized shrub ('Marie Simon') and large shrub ('Victoria'). California lilac attracts a wide number of different native bees across an extended bloom time.

TAKEAWAY: Don't just think about pollinator garden beds or meadows. Use bulbs, shrubs and trees to maximize pollinator resources.

Extend bloom time

7 Extending bloom time enables you to get more flowers for pollinators from a given plant. Some factors influencing bloom are beyond your control, such as hot and dry periods, which tend to reduce bloom time. Also, as perennials mature they tend to put out more flowers across a longer time than when they are young.

Some factors, however, may be within your control. Ensure plants are situated in environments that are best suited to them. Don't place a sun-loving plant in the shade. Giving plants the right amount of water or nutrients tends to extend bloom time.

Many perennials can bloom for exceedingly long periods when deadheaded, which is the practice of regularly removing flowers before they set seed. Pollinator plants that may extend bloom in response to deadheading include yarrow (*Achillea* spp.), lavender (*Lavender* spp.), wild bergamot (*Monarda fistulosa*), coreopsis (*Coreopsis* spp.), western coneflower (*Rudbeckia occidentalis*) and most asters.

TAKEAWAY: Keep plants blooming longer by ensuring they are planted in the right spot in the garden and deadheading flowers before they start to set seed.

Create nesting opportunities for bees

8 While many people pay attention to planting flowers for pollinators, few recognize the importance of nest sites for bees.

Bees, unlike other pollinating insects, build nests to raise their young and have specific requirements for their nests. Ground-nesting is of particular importance; approximately 70% of native bees in the Pacific Northwest nest underground in slender tunnels they dig using their mandibles, legs and special structures on their abdomen. Different species of bees have different preferences for soil types.

Gardeners and landscapers can encourage ground-nesting bees by protecting small areas of bare ground from mulching. These might include decorative rock features with bare patches of soil (Figure 9, page 15) or mounded-up soil on a garden edge.

There are also many bee species — including leafcutting, mason and resin bees, small carpenter bees and masked bees — that nest above ground in hollow or pithy stems. These bees can be encouraged to nest in dead stems from last year's growth. Good candidates include shrubs with hollow and pithy stems, like raspberries, grape vines, elderberry (*Sambucus* spp.) and sedum 'Autumn Joy'. Landscapers and gardeners can encourage these bees by including these plants and by not aggressively pruning out old growth. When cutting back old canes and stems, leave 6–8 inches of stem as habitat for cavity-nesting bees.

Finally, many bees that nest in stems need materials to construct chambers or cells within the stem to protect their young from parasites. Many species of

Photos: Andony Melathopoulos, © Oregon State University

Figure 9. Leaving some bare ground in urban landscapes encourages ground-nesting bees. Bare ground can be readily incorporated into landscape features, such as rock features. This rock feature in Madras, Oregon, has a host of nests made by sweat bees (*Halictus* sp., inset).

leafcutting bees are attracted to the leaves of common buckwheat (*Fagopyrum esculentum*) and will readily cut leaf discs from these plants to construct their cells.

Mason bees thrive when they have access to wet clay to build their cell partitions, which can be accomplished by creating a couple of small pits 4–6 inches in diameter to expose the clay. Keep these pits moist during bee nesting. For an excellent introduction to the biggest family of bees that nest in pithy stems, including mason and leafcutting bees, see *Megachilid Bees in the Pacific Northwest*, PNW 692 (*catalog.extension.oregonstate.edu/pnw692*).

TAKEAWAY: Leave some bare soil and some pithy or hollow twigs for bees to nest in, and provide nesting material to help the bees construct above-ground nests.

If you manage bees, manage them responsibly

9 Many people manage bees in urban settings. The two most popular species are honey bees (*Apis mellifera*) and blue orchard bees (*Osmia lignaria*), although there has been increasing use of the summer-nesting alfalfa leafcutting bee (*Megachile rotundata*). All these species are subject to diseases and parasites that must be properly managed to prevent the spread to neighboring managed colonies or nests, as well as to unrelated species of native bees.

Honey bees require the highest level of management and skill, compared to the other two species. Competent beekeeping requires hands-on training and mentoring (Figure 10). Access training programs through the Oregon State University and Washington State University extension services, local beekeeping clubs or supply companies. The Oregon Master Beekeeper program, run out of Oregon State University, provides a comprehensive training path for new beekeepers, including in parts of Washington and Idaho. (See *oregonmasterbeekeeper.org*.)

Training courses emphasize the management of the Varroa mite parasite (*Varroa destructor*), as well as diseases of honey bee brood and adults. While most pest and disease problems of honey bees do not require the use of chemical treatments, Varroa mites require routine chemical treatment. Failure to treat colonies for Varroa mites results in colony death and spreads mites to other honey bee colonies. The viruses associated with these mites also have been found to spread to native bee populations when mite populations are not controlled.

Honey bees in urban areas can become a nuisance to neighbors — either when the bees become defensive, when they swarm (such as during the seasonal division of the colony, when a portion of the colony departs in search of a new home) or when they defecate. Some municipalities may regulate how and where colonies can be placed in urban areas. Honey bees, however, can be successfully managed in ways that prevent their presence in urban areas from becoming a nuisance. Oregon State University has developed guidelines for nuisance-free beekeeping to help beekeepers (See *Residential Beekeeping: Best-Practice Guidelines for Nuisance-Free Beekeeping in Oregon*, EM 9186, *catalog.extension.oregonstate.edu/em9186*).

Blue orchard bees and alfalfa leafcutting bees provide an excellent alternative to honey bees in urban landscapes. These bees require far less management than honey bees and can be effective pollinators of garden plants. They typically will only sting when females are squeezed.

"Bee hotels" are often marketed to gardeners, as a way to attract or rear cavity-nesting pollinators (Figure 11, page 17). Bee hotels consist of a series of tubes or blocks with drilled holes where these two species, as well as a variety of related native bee species, will nest. This nesting material can build up diseases and parasites if not properly managed, resulting in their spread to other managed and wild populations of bees. People looking to install bee hotels should look for training from the Extension Service or from Master Gardener volunteers trained in solitary bee management. See also *Nurturing Mason Bees in Your Backyard in Western Oregon*, EM 9130, *catalog.extension.oregonstate.edu/em9130*.

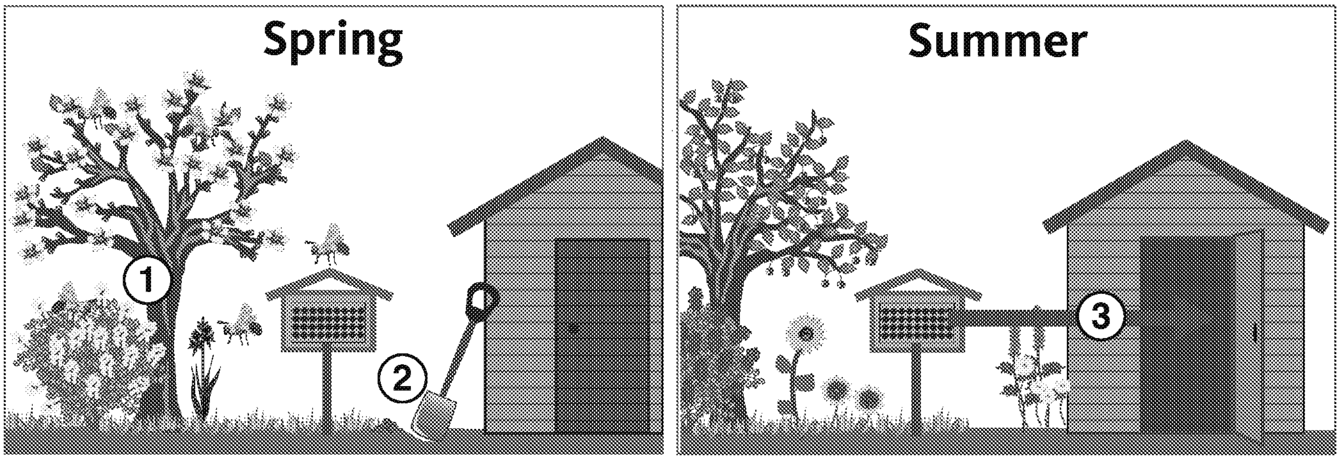
Finally, many people start their nests using cocoons containing live, developing bees purchased from garden centers or suppliers. There is a risk that cocoons from species of bees not currently found in the region can be accidentally introduced. These introduced bees, which include the Asian horned-face bee (*Osmia cornifrons*), may displace native bees. When purchasing cocoons, make sure they were sourced within the Pacific Northwest and follow best management standards established by the Orchard Bee Association (*orchardbee.org*) to prevent the spread of introduced bees, parasites and diseases.

TAKEAWAY: Before deciding to manage bees, seek training to make sure you can keep diseases and parasites under control. Learn how to prevent honey bees from becoming a nuisance. Also, before purchasing blue orchard bees, ensure they have been produced within the Pacific Northwest following industry best management standards.

Photo: Lynn Ketchum, © Oregon State University

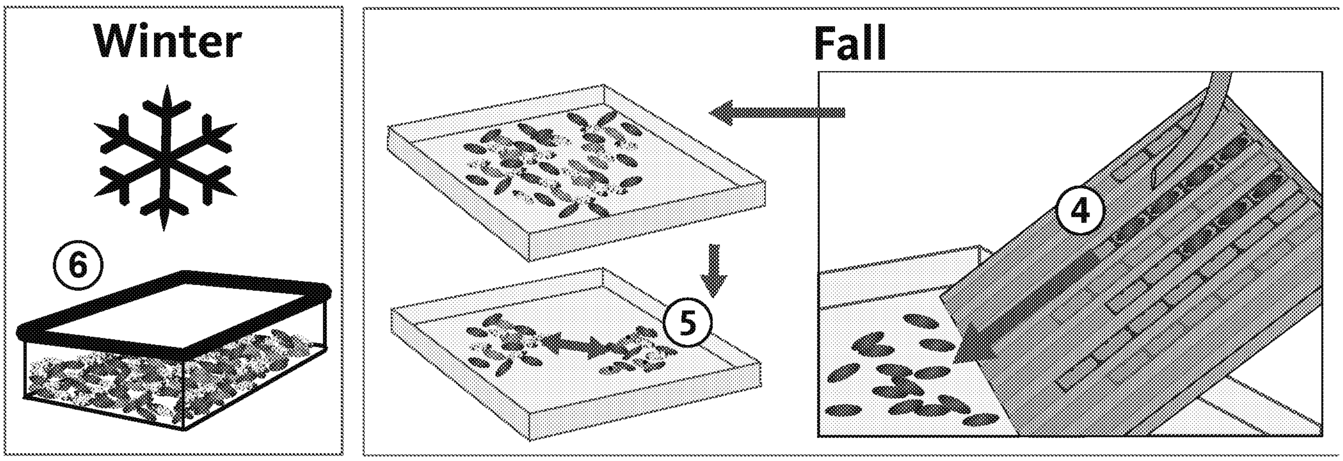
Figure 10. Cara Fritz searches for the queen in her backyard Corvallis hive. Beekeeping demands hands-on training and mentoring.

Figure 11. Tips for managing orchard bees



SPRING: Obtain clean cocoons or use cocoons wintered from the previous season. Place them in a sheltered nesting house stocked with nesting trays or tubes when day temperatures reach 50–55°F. Secure cocoons in a predator-proof box with one or two 5/16-inch. emergence holes. Ensure emerged bees have access to damp mud (1) and floral resources (2) for the next six weeks.

SUMMER: After adult bee foraging activity slows, protect the developing larvae from predators and parasitoids; move nesting trays or tubes into a pest-proof shed (3). Handle nesting material carefully to avoid dislodging larvae from their pollen provisions; keep mud plugs facing up.



WINTER: After separation and cleaning, store cocoons in a refrigerator at 39°F and 60%–70% humdity (6). Humidity can be maintained by keeping a small moistened towel along with the cocoons in a ventilated container.

FALL: Separate cocoons from their nesting material and clean them (4). Cocoons with disease or signs of parasitism should be discarded (5). Novices should contact their local Extension office to find fall classes on orchard bee culture.

Graphic: Iris Kormann, © Oregon State University

Reduce or eliminate insecticide use

10 Pesticides can have negative impacts on pollinators. Insecticides, in particular, can directly and immediately reduce insect pollinator populations. Using insecticides around pollinators in a manner that reduces exposure can be complicated, particularly for homeowners who lack the training required of licensed pesticide applicators. In many cases, insect pests in urban landscapes can be managed without insecticides. The sections that follow outline some approaches to managing pests using plant selection and site preparation.

TAKEAWAY: Insecticide use can have negative impacts on insect pollinators, and most insect pests in urban landscapes can be managed without using insecticides. Avoid using insecticides whenever possible.

Selecting, planting and caring for trees and shrubs to avoid the need for pesticides

The best way to minimize pollinator exposure to pesticides is to create and maintain healthy landscapes with plants that rarely, if ever, require a pesticide application. All plants will be their healthiest when their needs are fully met. It is especially important to provide suitable conditions for long-lived trees and shrubs.

Choose perennials, shrubs and trees that are adapted to your climate and soil type. Make sure they are winter-hardy in your area and will get the amount of sunlight they require. Keep in mind that urban soils may be distinct from the native soil type in your region. In addition, urban climate conditions may be somewhat different from the prevailing regional climate, due to extensive paving that can create "heat islands" in the city. Some of the most important considerations needed to establish healthy plants include site selection and securing healthy stock.

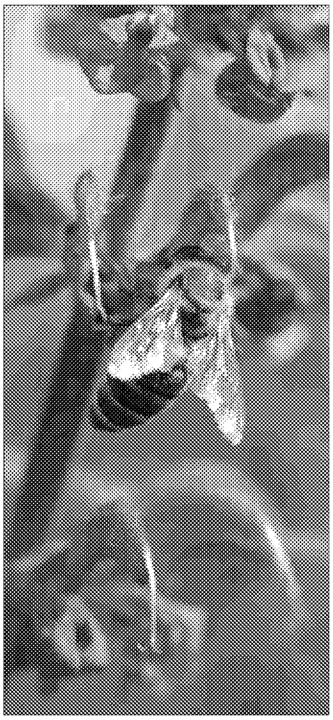


Photo: Vera Buhl, CC BY-SA 1.0

Figure 12. Blue salvia attracts bees, but the popular annual red salvia does not.

Selecting and acquiring plants

It is important to use the genus or species name (also known as the scientific name) when you investigate and buy your perennials, trees and shrubs. Common names may be regional and could refer to a different type of flower, depending upon local tradition. Where possible, locate the exact species listed below because other species in the same genus may not be as attractive to pollinators. Salvia, for example, is a popular annual bedding plant, but annual red salvia is not attractive to bees, while blue salvia (*Salvia farinacea*) and several types of perennial salvia (*Salvia nemorosa*), are attractive (Figure 12).

Make sure the plant you are considering is winter-hardy in the climate zone where you live. This is easy to do using the USDA Plant Hardiness Zone Map: *planthardiness.ars.usda.gov/PHZMWeb/*. This website has an interactive map of plant hardiness zones for all of the U.S. Perennials, trees and shrubs at garden centers should have the cold-hardiness zone listed on the tag of each plant. If your area is listed as zone 5b, for example, make sure the plants you buy have zone 5b or a smaller number listed. (Smaller numbers are more cold hardy.)

Photo: Gary Warren, CC BY-3.0

Figure 13. Butterfly bush is a popular plant with gardeners and with butterflies, but many varieties of the species are invasive.

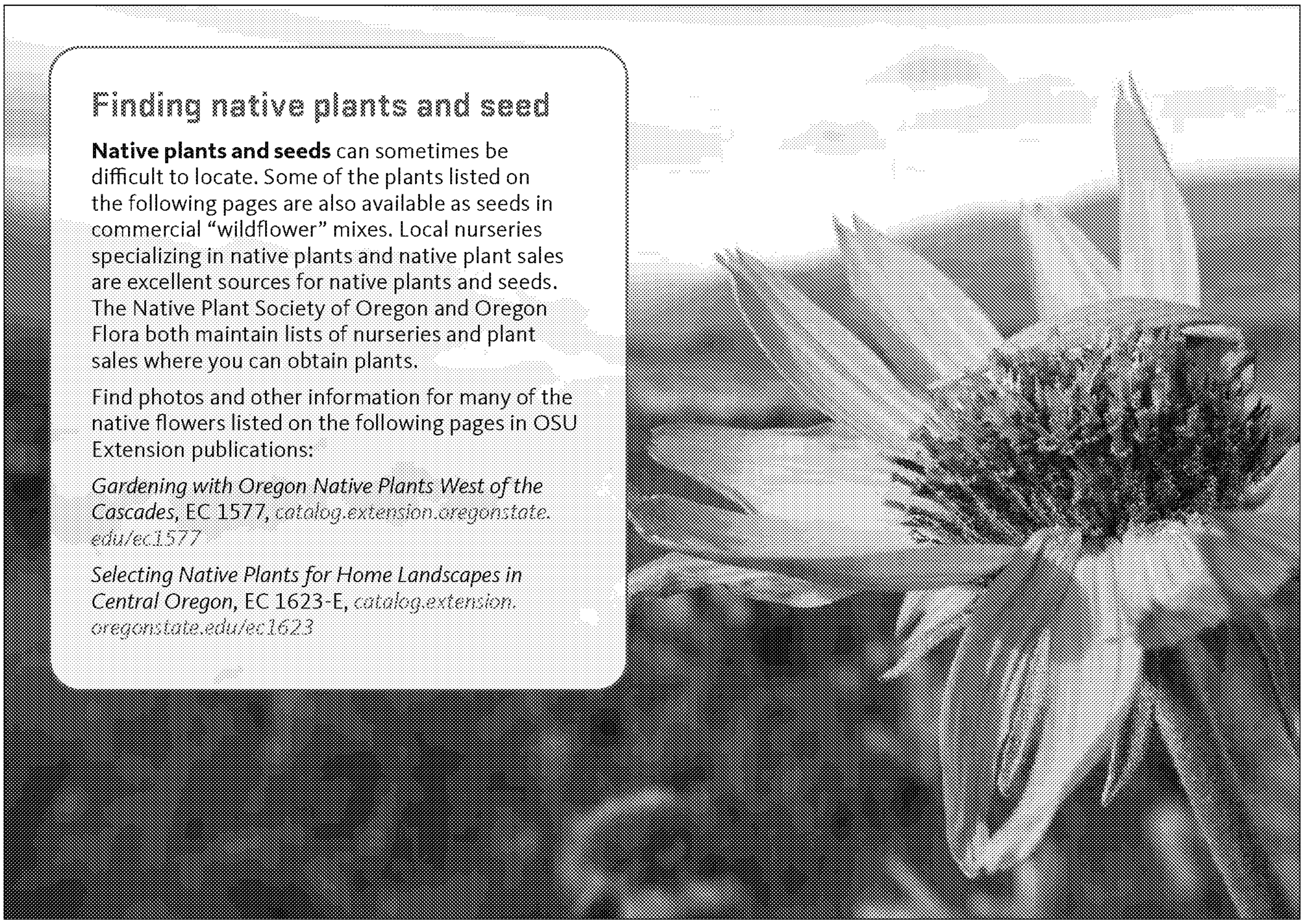
Do not choose plants known to have major pest or disease problems (Table 2, page 19). The best way to avoid the need for pesticides is to choose pest-resistant plants. Review the problem-prone plants in the table before buying plants. Consider the resistant cultivars or alternative plant types with the same characteristics. There are guides available for choosing other trees and shrubs as alternatives to the problem-prone trees listed.

Choose plants that don't require excessive watering (See *Water-wise Gardening in Central Oregon*, EM 9136, *catalog.extension.oregonstate.edu/em9136*.)

It is also important not to select plants that will facilitate the spread of invasive weeds in the region. Some highly attractive exotic plants are invasive and can cost the state millions of dollars to control (Figure 13). These include butterfly bush (*Buddleja davidii*, although noninvasive sterile varieties are available), bachelor's button (*Centaurea cyanus*), jewelweed (*Impatiens glandulifera*) and European hawthorn (*Crataegus monogyna*). *GardenSmart Oregon: A Guide to Non-Invasive Plants*, *portlandoregon.gov/bes/article/197414*, lists common invasive plants in Oregon and provides ornamental and native plant alternatives for areas west of the Cascades.

Table 2. Problem-prone trees and shrubs that may need pesticide treatment to remain healthy

Common name	Scientific name	Potential concerns and alternatives
Boxelder	*Acer negundo*	A weak-structured tree that hosts boxelder bugs, a nuisance in houses. Seeds and seedlings may be a problem. Consider planting native vine maple (*Acer circinatum*), eastern redbud (*Cercis canadensis*) or western redbud (*Cercis occidentalis*) as an alternative with high pollinator value.
European white birch	*Betula pendula*	All European and Asian cultivars are highly susceptible to bronze birch borer. *Betula nigra* (river birch) is most resistant. Birches are thought to be of relatively low value to pollinators, so alternatives listed for boxelder are good choices.
Boxwood	*Buxus* spp.	Susceptible to boxwood leaf miner, boxwood psyllid. Alternative evergreen shrubs that attract pollinators and can be sheared include Japanese holly (*Ilex crenata*), inkberry holly (*Ilex glabra*), semi-evergreen glossy abelia (*Abelia x grandiflora*) or rosemary (*Rosmarinus officinalis*).
Tulip tree	*Liriodendron*	See *Tilia* spp.
Apple and crabapple	*Malus* spp.	Many cultivars susceptible to apple scab, fire blight and codling moth. But these are valuable pollinator plants, so consider planting resistant cultivars such as Adirondack or Sargent crabapple (*Malus* 'Adirondack', *M. sargentii*). Western serviceberry (*Amelanchier alnifolia)* is a spring-blooming native tree also good for pollinators.
Cherry, peach, plum	*Prunus* spp.	Variously susceptible to bacterial canker, Armillaria crown and root rot, peach leaf curl, little cherry disease and other diseases. Shrubs and trees in this genus are valuable pollinator plants, so consider planting more resistant cultivars such as Akebono cherry (*Prunus* x *yedoensis* 'Akebono'). Western serviceberry is also a good a native spring-blooming alternative to these trees.
Rhododendron/azalea	*Rhododendron* cvs.	Susceptible to azalea bark scale, azalea and rhododendron lace bug, rhododendron or black vine root weevil. Rhododendrons from the PJM group are an excellent option in central Oregon and are resistant to root weevil. Excellent evergreen alternatives west of the Cascades with high value to pollinators include California lilac (*Ceanothus* spp.) or manzanita (*Arctostaphylos* spp.) for sunny, dry sites, and huckleberry (*Vaccinium ovatum*) or Oregon grape (*Mahonia/Berberis aquifolium*) for shadier sites.
Rose	*Rosa* spp. and cvs.	Roses are susceptible to black spot, rust, powdery mildew and aphids. Look for resistant cultivars and species such as *Rosa rugosa*, which is an excellent source of pollen and nectar for bees. Roses with single flowers — especially native species — are best for pollinators.
Common lilac	*Syringa vulgaris*	Prone to powdery mildew, scale insects and bacterial blight. Look for resistant cultivars, or consider California lilac (*Ceanothus* spp.), chaste tree (*Vitex agnus-castus*), native red- or white-flowering currant (*Ribes sanguineum*) or bluebeard (*Caryopteris* spp.).
Linden, basswood, lime	*Tilia* spp.	Linden trees are susceptible to aphids and thrips that secrete sticky honeydew. These sucking insects do not damage trees, and trees can be useful pollinator plants where honeydew secretions are not a problem (on an acreage, where the honeydew will not develop into a nuisance). Alternatives listed for boxelder are good choices for shade trees with value to pollinators.



Finding native plants and seed

Native plants and seeds can sometimes be difficult to locate. Some of the plants listed on the following pages are also available as seeds in commercial "wildflower" mixes. Local nurseries specializing in native plants and native plant sales are excellent sources for native plants and seeds. The Native Plant Society of Oregon and Oregon Flora both maintain lists of nurseries and plant sales where you can obtain plants.

Find photos and other information for many of the native flowers listed on the following pages in OSU Extension publications:

Gardening with Oregon Native Plants West of the Cascades, EC 1577, catalog.extension.oregonstate.edu/ec1577

Selecting Native Plants for Home Landscapes in Central Oregon, EC 1623-E, catalog.extension.oregonstate.edu/ec1623

Photo: Lomatium, © CC BY-NC 2.0

Site selection and preparation: 5 top tips

The following considerations are critical for planning your pollinator landscape:

Anticipate plant sizes and arrange accordingly

1 When siting trees and large shrubs, allow enough space for the root system and branches to grow to full size. Look up the maximum height they will grow to and make sure it is appropriate for the site. Trees and shrubs need room for roots to grow down and outward from the trunk. In general, small trees should not be planted any closer than 8 feet from a building or imperviously paved area. Site large trees at least 15 feet from buildings or paved areas; 20 feet or more is better.

Check soil pH

2 Plant labels often list appropriate soil pH levels. Make sure your soil pH falls within the range considered adequate for the plant type you are considering. Rhododendrons, blueberries and other plants in the heather family (Family: Ericaceae), for instance, prefer a somewhat acid soil (pH 4.5–5.5). Acid soil is common in western Oregon — one reason these plants thrive here. East of the Cascades, a higher pH is more common, and acid-loving plants can be challenging to grow. Some trees such as red maple, pin oak and white pine do not grow well in soil with pH above 6.5. The best way to learn your soil's pH is to send a sample to a soil lab. See *Analytical Laboratories Serving Oregon*, EM 8677, catalog.extension.oregonstate.edu/em8677.

Check light and moisture requirements of plants

3 Some plants do not grow well in shady sites, while others prefer some shade. Find light and moisture requirements on the plant's label and group plants in locations where they will receive enough sunlight to thrive. In general, the plants most attractive to pollinators prefer full sun or mostly sun, so a pollinator garden located in a sunny location will be most successful.

Prepare planting sites properly

4 If you are preparing a large area, make sure to thoroughly remove weeds — especially perennial ones — before starting to plant. Spray weeds with an appropriate herbicide or smother them by covering mowed areas with a deep layer of mulch through at least one growing season. In the case of especially pernicious weeds, such as bindweed or Canada thistle, couple hand-removal with targeted and properly timed applications of herbicide.

For a site that will be primarily trees and shrubs, arborist wood chips are the best choice for mulch in areas that are not prone to wildfire. The wood chips will gradually break down and improve the soil. If soil testing reveals the need for amendments, layer them beneath the mulch. For a perennial border, consider a mulch of compost over cardboard. Till in the cardboard-compost layer after the weeds are dead and the cardboard has broken down.

Trees planted individually need a somewhat different approach. Dig a hole at least twice as wide as the root ball, but no deeper than the height of the root ball. Make sure that water drains well from the planting site. Remove the pot, wire or other containment from the root ball; don't remove burlap until the tree is in the ground. It is especially important to loosen and spread out the roots before planting, and make sure none are wrapped around the trunk (girdling). Depending on how rootbound the tree is, you may need to uncoil or cut roots, remove potting mix with a high-powered water spray, or even slice off the sides and bottom of the root mass. Although these methods may seem harsh, they are better than planting a tree with a tangled root system. When the roots are loosened, place the root ball in the hole so the area where the roots start to flare outward from the trunk (the root flare) is 1–2 inches above the surrounding soil surface. This will allow for settling.

After placing the tree in the planting hole, backfill with soil. West of the Cascades, backfill with unamended soil from the hole. East of the Cascades, mix one-third amendment with two-thirds native soil to encourage root establishment and increase the water-holding capacity of the planting site. Following backfilling, water the tree well and place a 2–4-inch layer of mulch around the tree, out at least to the drip line (but not piled against the trunk).

Avoid drought stress

5 Drought is a common stressor of many plants, particularly in areas that do not receive summer rains. Because we see flowers wilt when they lack water, people understand the importance of frequently watering flowerbeds. They may underestimate the need of trees and shrubs for supplemental water, but those are also weakened by prolonged water stress. Drought stress encourages insect and disease problems that may require a pesticide. In fact, adequate soil moisture may be the most important factor in maintaining healthy ornamental plants that are resistant to pests.

The most critical time to provide water is during the establishment period — the dry summer seasons for the first several years after trees and shrubs are planted. After that, some may be able to survive on little or no summer water (west of the Cascades), although most plants will look better with a little supplemental moisture during the driest stretches. Non-native plants do not survive without supplemental irrigation in southern and central Oregon. Remember, too, that the climate is getting warmer and drier, so plants that can survive a dry summer now may fail during drier times.

Understanding plant names

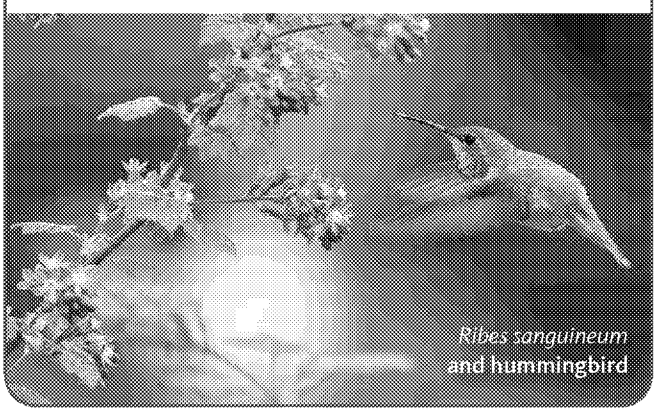
The botanical name of a plant includes the genus and the species name, both of which are italicized. For example, *Ribes sanguineum* is a species of red-flowering currant native to western Oregon. When referring to several species within a genus, the botanical name may be abbreviated as *Genus* spp., where only the genus name is italicized. For example, *Ribes* spp. is used when referring to any of several species of flowering currant.

A plant cultivar is one that has been selected for desirable traits that are maintained during propagation. Cultivar names are written so that the botanical name is followed by a 'cultivar epithet'. The 'cultivar epithet' is given in single quotes. For example, *Ribes sanguineum* 'Snowflake' is a cultivar of a currant that was derived from the plant native to Oregon.

A plant hybrid is a cross between two different species. Hybrids are not cultivars. For example, *Lavandula* x *intermedia* is a cross between English lavender (*Lavandula angustifolia*) and Portuguese lavender (*Lavandula latifolia*).

A hybrid may be further selected for desirable traits that are maintained by propagation. In these cases, the hybrid will also bear a 'cultivar epithet'. Examples of hybrid cultivars would be *Lavandula* x *intermedia* 'Grosso' or *Lavandula* x *intermedia* 'Provence'.

Photo: Mikul/CC 2.0



Ribes sanguineum and hummingbird

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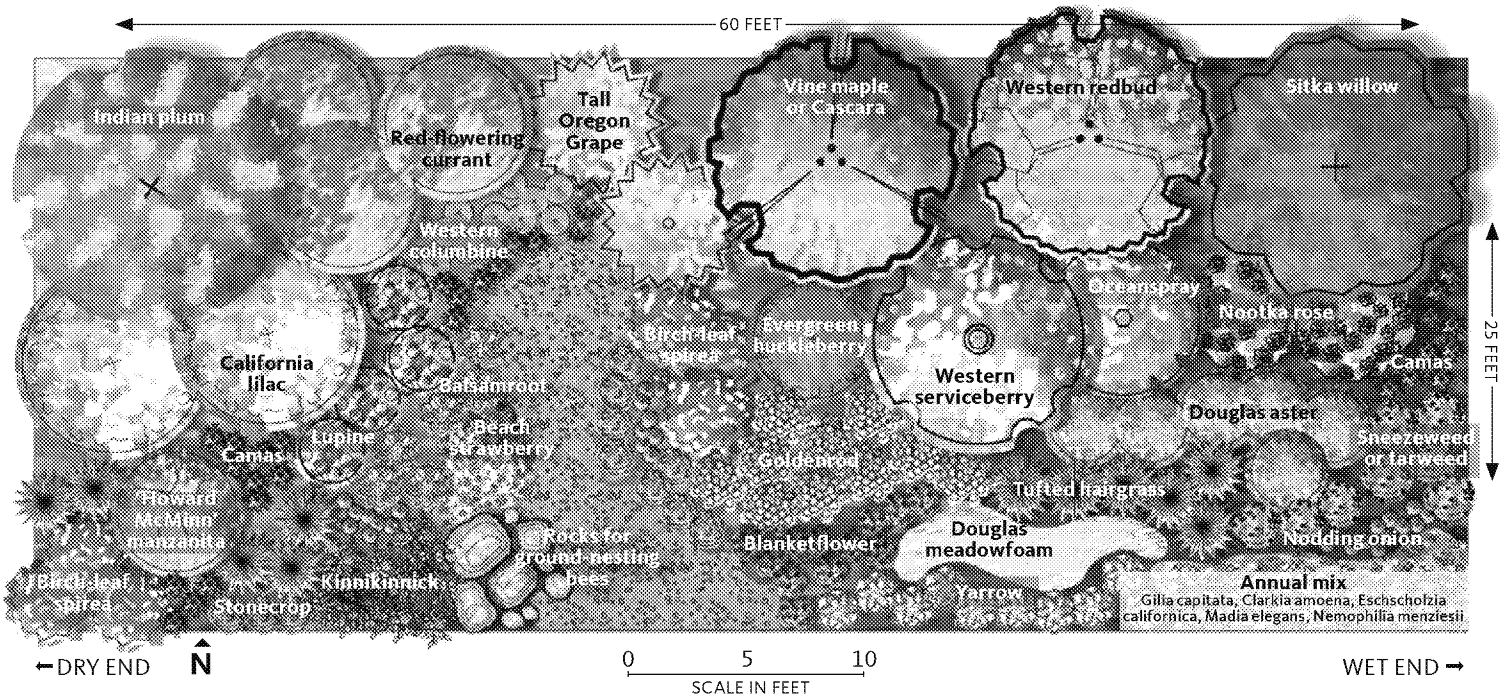
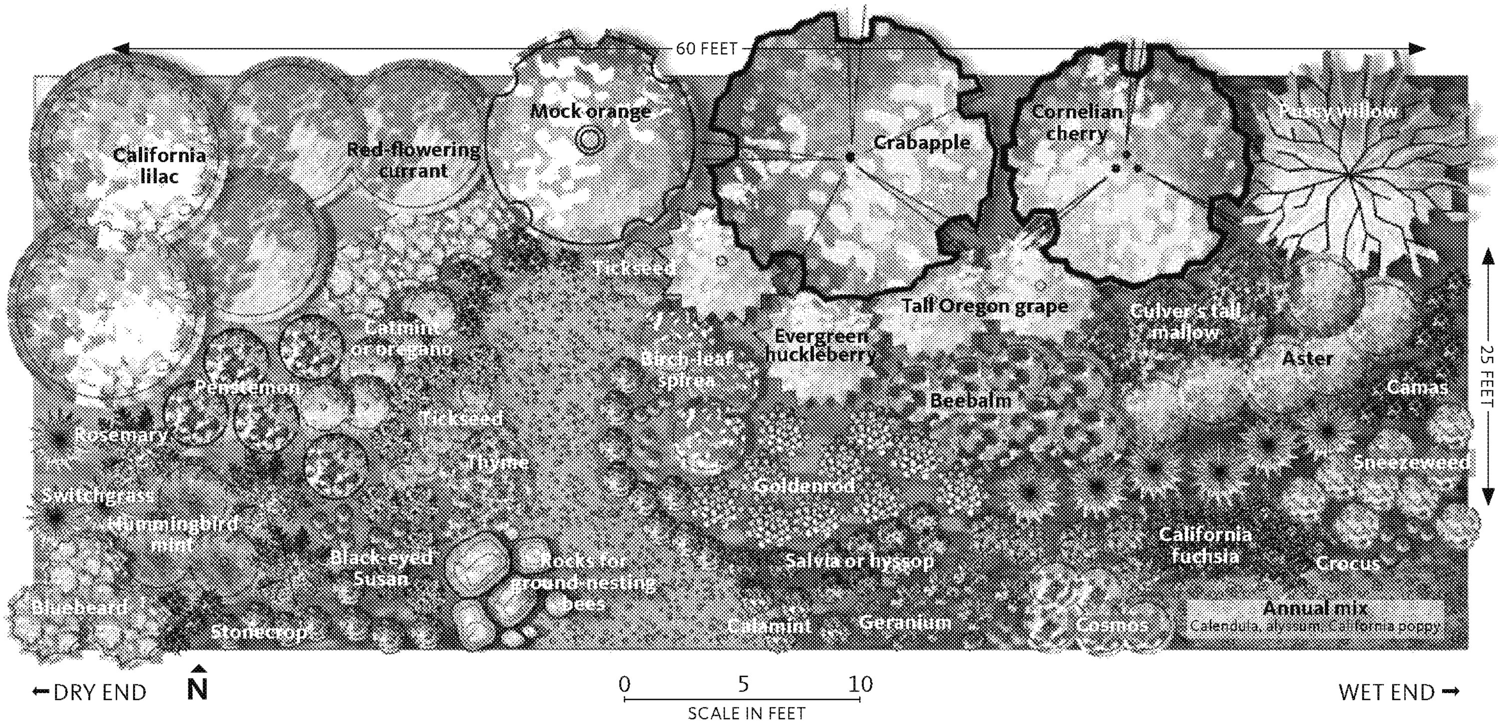
Pollinator garden designs

Native plant garden SPRING THROUGH AUTUMN, WEST OF THE CASCADES



Native and non-native garden SPRING THROUGH AUTUMN, WEST OF THE CASCADES



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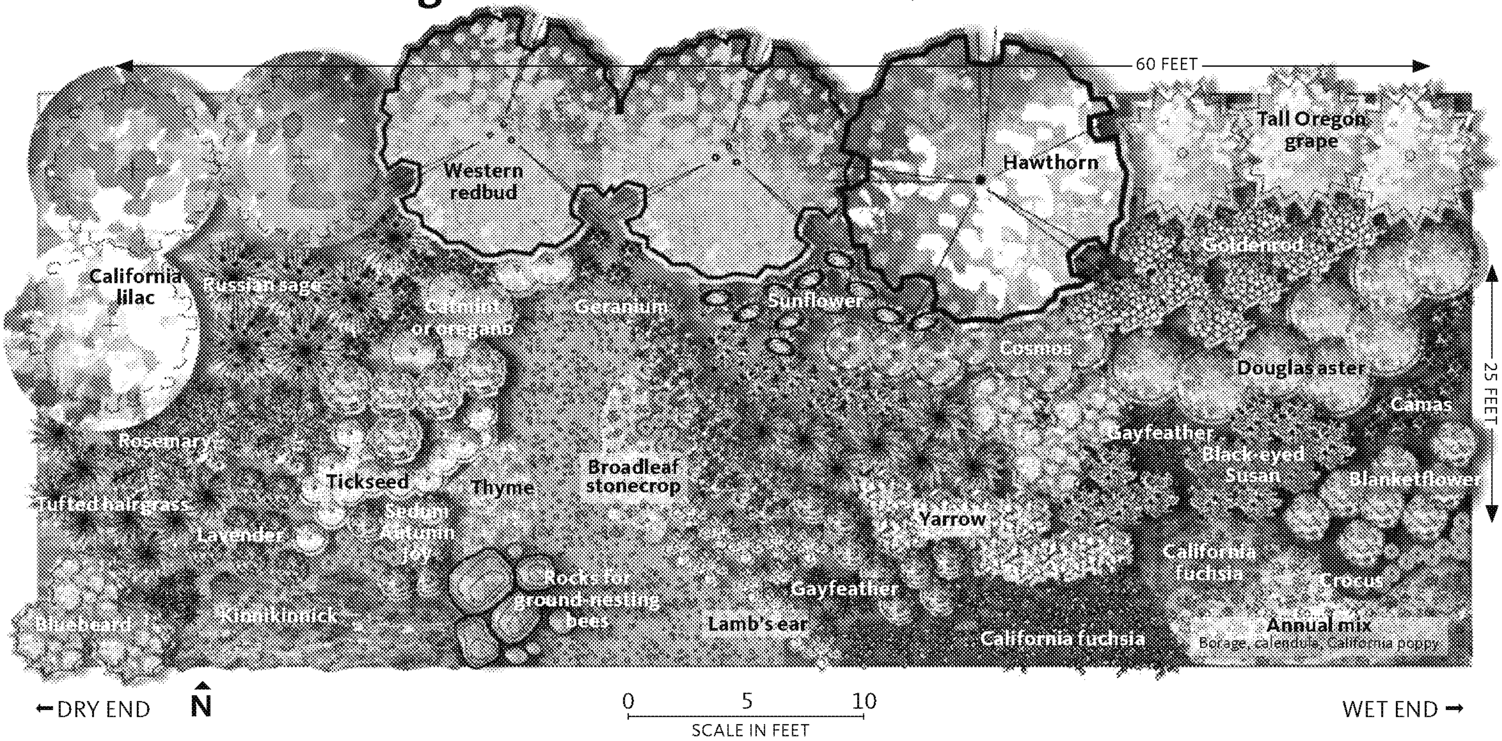
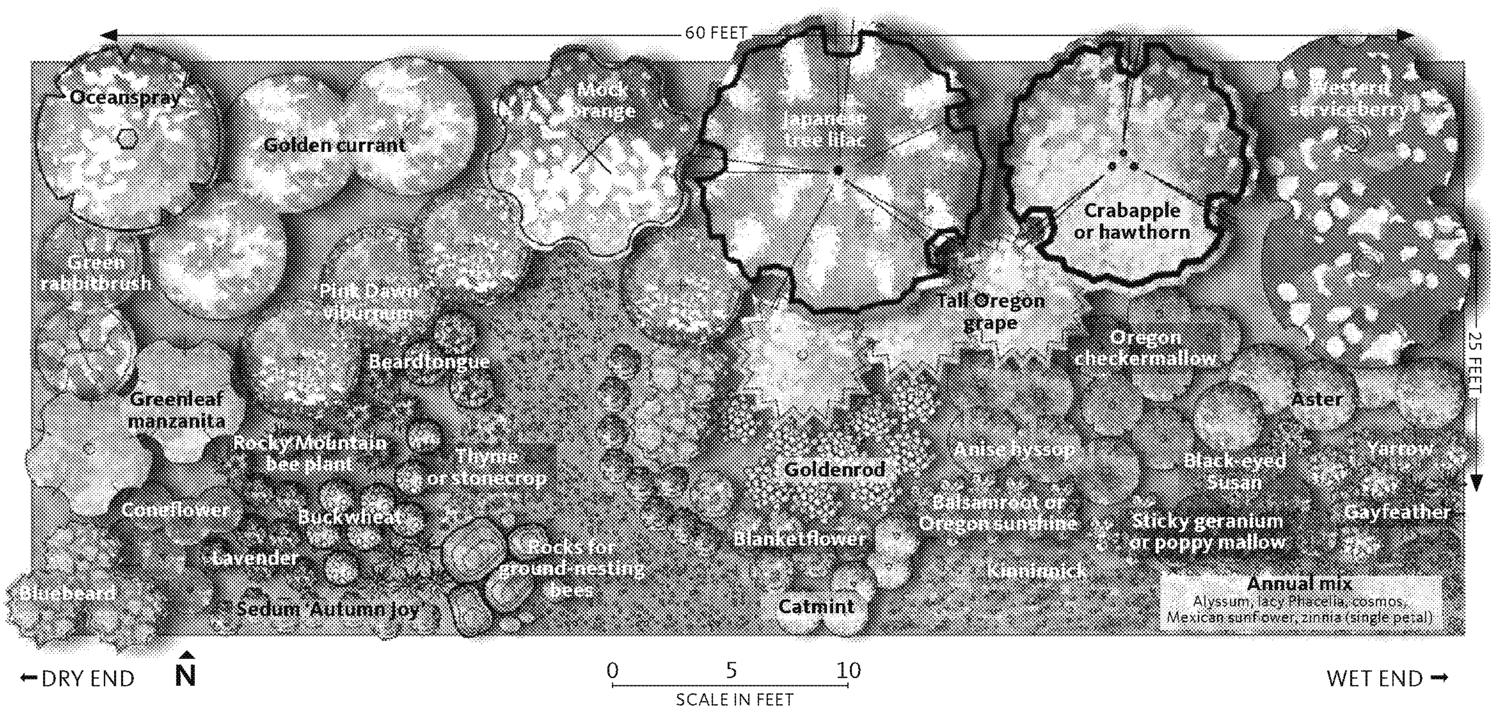
Low-maintenance garden SPRING THROUGH AUTUMN, WEST OF THE CASCADES



Central and southern Oregon pollinator garden SPRING THROUGH AUTUMN



Garden designs: Signe Danler, © Oregon State University

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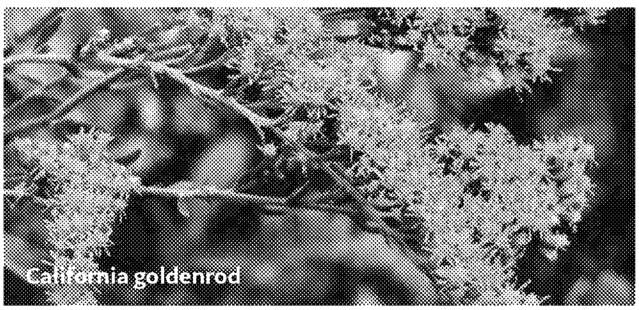
Pollinator profile: native plant garden

Three seasons of plants attractive to pollinators


Large camas

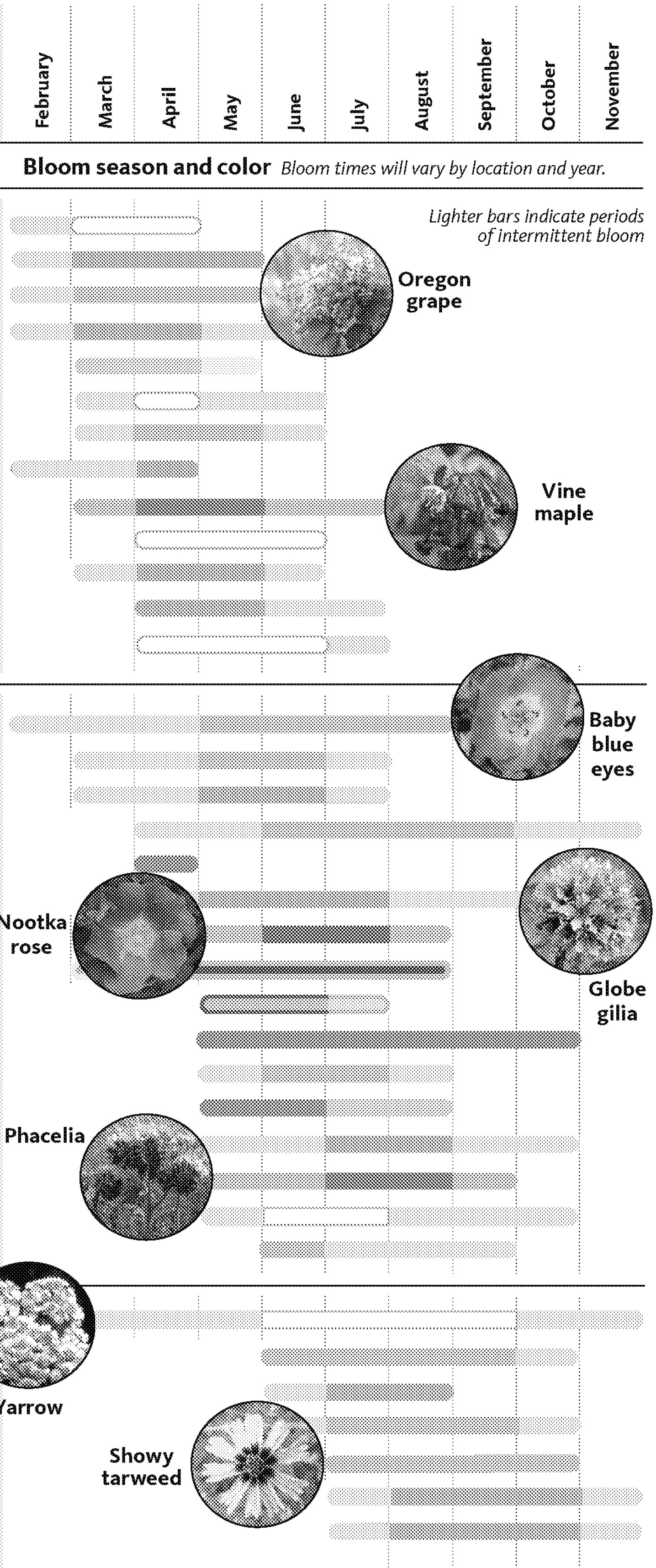

Western columbine


California goldenrod

Common name	Scientific name
Osoberry, Indian-plum	*Oemleria (Osmaronia) cerasiformis*
Kinnikinnick, bearberry	*Arctostaphylos uva-ursi*
Tall Oregon grape	*Mahonia (Berberis) aquifolium*
Red-flowering currant	*Ribes sanguineum*
Sitka willow	*Salix sitchensis*
Western serviceberry	*Amelanchier alnifolia*, spp.
Douglas meadowfoam	*Limnanthes douglasii*
Manzanita	*Arctostaphylos 'Howard McMinn'*
Vine maple	*Acer circinatum*
Cascara	*Rhamnus (Frangula) purshiana*
Large camas	*Camassia leichtlinii* or *quamash*
Beach or woods strawberry	*Fragaria chiloensis or vesca*
Evergreen huckleberry	*Vaccinium ovatum*
Baby blue eyes	*Nemophila menziesii*
Balsamroot, mule's ears	*Balsamorhiza deltoidea*
California lilac	*Ceanothus 'Victoria', 'Julia Phelps'*
California poppy	*Eschscholzia californica*
Western redbud	*Cercis occidentalis*
Globe gilia	*Gilia capitata*
Nootka rose	*Rosa nutkana*
Blanketflower	*Gaillardia aristata*
Western columbine	*Aquilegia formosa*
Godetia, farewell to spring	*Clarkia amoena*
'Capo Blanco' broadleaf stonecrop	*Sedum spathulifolium 'Cape Blanco'*
Birchleaf spirea	*Spirea betulifolia*
Summer lupine	*Lupinus formosus*, spp.
Phacelia	*Phacelia* spp.
Oceanspray	*Holodiscus discolor*
Tufted hairgrass	*Deschampsia cespitosa*
Common yarrow	*Achillea millefolium*
Sneezeweed	*Helenium autumnale*
Nodding onion	*Allium cernuum*
California goldenrod	*Solidago californica*
Showy tarweed	*Madia elegans*
Pacific aster	*Symphyotrichum/Aster chilensis*
Douglas aster	*Symphyotrichum/Aster subspicatum*

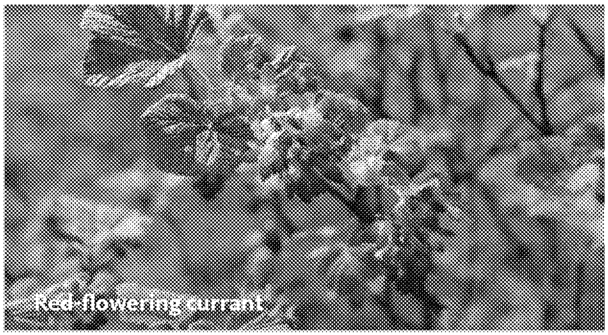
Type	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
Type	**Pollinators**							**Growing conditions**					
Shrub			◆	◆	◆	◆	◆	◆	◆		◆	◆	◆
Groundcover	◆	◆	◆				◆	◆			◆		
Shrub	◆	◆	◆	◆			◆	◆	◆		◆	◆	◆
Shrub		◆	◆	◆			◆	◆	◆		◆	◆	
Shrub	◆		◆	◆	◆		◆			◆	◆		
Shrub	◆		◆		◆		◆		◆	◆	◆	◆	
Annual	◆		◆						◆	◆	◆		
Shrub	◆	◆	◆					◆			◆		
Tree	◆	◆					◆		◆			◆	
Tree			◆				◆		◆		◆	◆	
Bulb	◆		◆		◆		◆		◆	◆	◆	◆	
Groundcover							◆	◆	◆		◆	◆	
Shrub		◆	◆	◆			◆		◆		◆	◆	
Annual			◆						◆		◆	◆	
Perennial			◆		◆			◆			◆		
Shrub	◆	◆	◆				◆	◆	◆		◆	◆	
Annual	◆	◆	◆				◆	◆	◆		◆		
Tree	◆	◆	◆	◆	◆		◆	◆	◆		◆	◆	
Annual	◆		◆		◆			◆	◆		◆		
Shrub	◆	◆	◆		◆		◆		◆		◆	◆	
Perennial			◆		◆		◆	◆	◆		◆		
Perennial	◆	◆	◆	◆			◆	◆	◆			◆	
Annual		◆	◆					◆	◆		◆		
Perennial		◆	◆		◆		◆	◆	◆		◆	◆	
Shrub			◆		◆				◆		◆	◆	
Perennial		◆	◆		◆		◆	◆	◆		◆	◆	
Ann./perennial		◆	◆		◆			◆	◆		◆	◆	
Shrub		◆	◆		◆		◆	◆	◆		◆	◆	
Grass					◆		◆	◆	◆		◆	◆	
Perennial			◆		◆		◆	◆	◆		◆	◆	
Perennial	◆		◆						◆		◆		
Bulb	◆	◆	◆		◆		◆	◆	◆		◆	◆	
Perennial	◆	◆	◆		◆				◆		◆	◆	
Annual			◆		◆			◆	◆		◆	◆	
Perennial	◆	◆	◆		◆		◆		◆		◆	◆	
Perennial			◆		◆			◆	◆	◆	◆	◆	

Bloom season and color *Bloom times will vary by location and year.*



Pollinator profile: native and non-native garden

Three seasons of plants attractive to pollinators


Red-flowering currant

	Common name	Scientific name
	Crocus	*Crocus sativus*, spp.
	Cornelian cherry	*Cornus mas*
N	**Tall Oregon grape**	*Mahonia (Berberis) aquifolium*
N	**Red-flowering currant**	*Ribes sanguineum* and cvs.
	Rosemary	*Rosmarinus officinalis*
	Pussy willow	*Salix discolor*
N	**Camas ssp.**	*Camassia spp*
	Crabapple	*Malus floribunda*


Hummingbird mint

	Common name	Scientific name
N	**California lilac**	*Ceanothus 'Victoria', 'Julia Phelps'*, cvs.
N	**California poppy**	*Eschscholzia californica*
	'Walker's Low' catmint	*Nepeta x faasenii 'Walker's Low'*, cvs.
	Smooth beardtongue	*Penstemon digitalis 'Husker Red'*, spp.
N	**Mock orange**	*Philadelphus lewisii* and cvs.
	Thyme & cvs.	*Thymus vulgaris*, and cvs.
N	**Birch-leaf spirea**	*Spirea betulifolia*
N	**Stonecrop**	*Sedum spathulifolium 'Capo Blanco'*
	'Zebrina' tall mallow	*Malva sylvestris 'Zebrina'*
	Pot marigold	*Calendula officinalis*
	Largeflower tickseed	*Coreopsis grandiflora*
	Alyssum	*Lobularia maritima*
N	**Black-eyed Susan**	*Rudbeckia hirta*
	'Mardi Gras' sneezeweed	*Helenium 'Mardi Gras'*, and cvs.
N	**Anise hyssop, hummingbird mint**	*Agastache foeniculum* and cvs., spp.
	Lesser calamint	*Calamintha (Clinopodium) nepeta*
	'Rozanne' hardy geranium, & cvs.	*Geranium 'Rozanne'*, and cvs.
	'Indigo Spires' salvia	*Salvia x 'Indigo Spires'*, spp.
N	**Common yarrow**	*Achillea millefolium* and cvs.


Aster

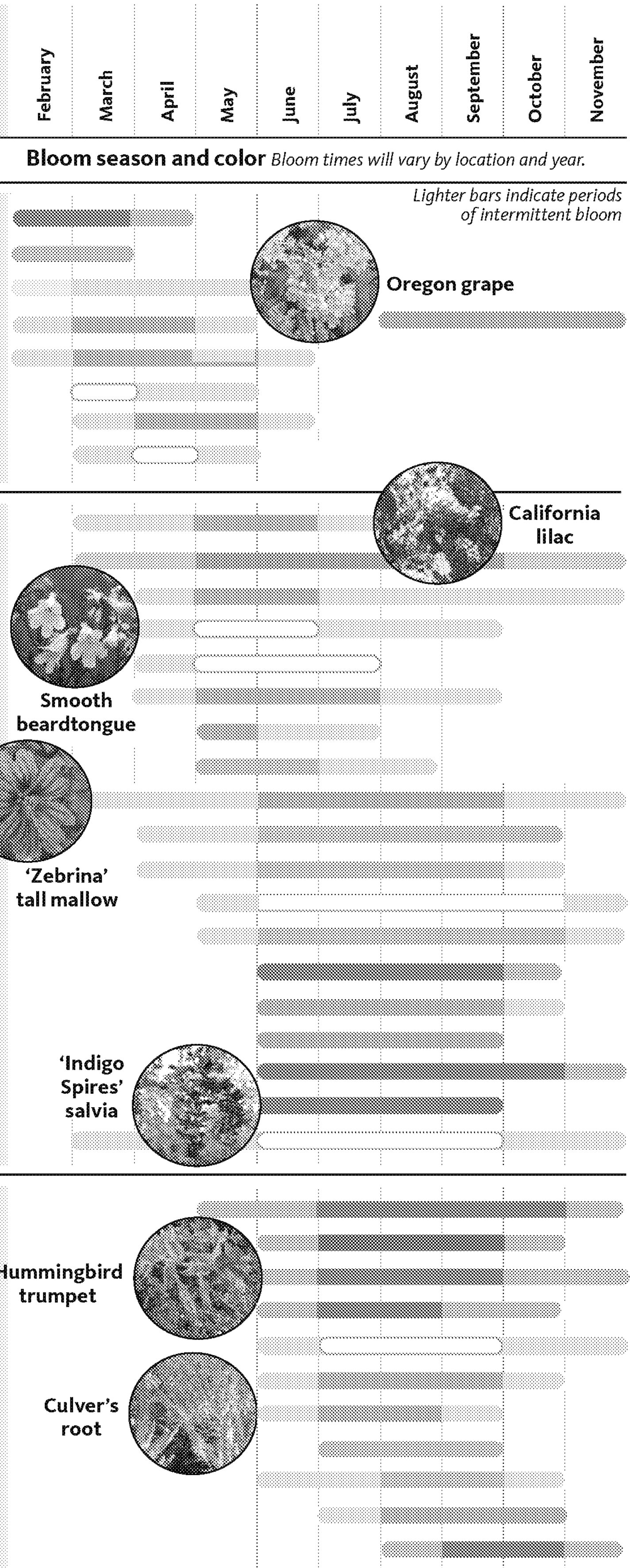
	Common name	Scientific name
	Bluebeard	*Caryopteris x clandonensis* and cvs.
	Cosmos	*Cosmos bipinnatus*
	California fuschsia	*Epilobium (Zauschneria) canum* and cvs.
	Scarlet beebalm	*Monarda didyma 'Cambridge Scarlet'*
	Oregano, marjoram, etc.	*Origanum vulgare*, cvs.
	Culver's root	*Veronicastrum virginicum*
	Hyssop	*Hyssopus officinalis*
	Switchgrass	*Panicum virgatum*
N	**Canada goldenrod**	*Solidago canadensis*
	'Autumn Joy' stonecrop	*Sedum spectabile 'Autumn Joy'*
	Aster	*Symphyotrichum/ Aster spp*, cvs.

Red-flowering currant: Pat Breen, ©2018 Oregon State University. Hummingbird mint: Ryan Moehring, U.S. Fish and Wildlife Service, CC2.0. Aster: William M. Ciesla, Forest Health Management International, Bugwood.org

N = Northwest native

Type	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
Type	**Pollinators**												
Bulb	◆	◆			◆			◆	◆			◆	
Tree	◆							◆	◆		◆	◆	
Shrub	◆	◆	◆	◆			◆	◆	◆		◆	◆	◆
Shrub		◆	◆	◆			◆	◆	◆			◆	
Subshrub	◆	◆	◆					◆			◆		
Shrub	◆		◆	◆	◆		◆		◆	◆		◆	
Bulb	◆		◆		◆		◆		◆	◆		◆	
Tree	◆	◆	◆				◆		◆			◆	
Shrub	◆	◆	◆				◆	◆	◆			◆	
Annual	◆	◆	◆				◆	◆	◆		◆		
Perennial	◆	◆	◆		◆			◆	◆		◆		
Perennial	◆	◆	◆	◆	◆				◆			◆	
Shrub	◆	◆	◆	◆	◆		◆		◆			◆	
Groundcover	◆	◆	◆		◆			◆	◆		◆		
Shrub			◆		◆				◆			◆	
Perennial		◆	◆		◆		◆	◆	◆		◆	◆	
Perennial	◆	◆	◆						◆			◆	
Annual	◆	◆	◆		◆				◆			◆	
Perennial			◆		◆			◆	◆		◆		
Annual			◆		◆				◆			◆	
Perennial	◆	◆	◆		◆	◆			◆	◆		◆	
Perennial	◆		◆				◆		◆	◆		◆	
Perennial	◆	◆	◆	◆	◆			◆	◆		◆		
Perennial	◆		◆						◆			◆	
Perennial			◆		◆				◆			◆	
Perennial	◆	◆	◆	◆					◆		◆		
Perennial			◆		◆		◆	◆	◆		◆	◆	
Shrub	◆	◆						◆	◆		◆		
Annual	◆	◆			◆				◆		◆		
Perennial	◆	◆		◆	◆			◆			◆		
Perennial		◆	◆	◆	◆				◆	◆		◆	
Subshrub	◆	◆	◆		◆			◆	◆		◆		
Perennial	◆	◆	◆		◆	◆			◆	◆		◆	
Perennial	◆	◆	◆		◆			◆	◆		◆		
Grass					◆				◆			◆	
Perennial		◆	◆		◆				◆			◆	
Perennial	◆				◆			◆	◆		◆	◆	
Perennial		◆	◆		◆		◆		◆			◆	

Bloom season and color *Bloom times will vary by location and year.*



Oregon grape: Robert Vidéki, Doronicum Kft., Bugwood.org. California lilac: Signe Danler, © Oregon State University. *Smooth beardtongue:* © 2016, Keir Mace, *CC BY-NC 3.0.* 'Zebrina' tall mallow: ©2005 Luigi Rignanese, *CC BY-NC 3.0.* *'Indigo spires' salvia:* KENPEI, *CC2.5. Hummingbird trumpet:* Dick Culbert, *CC 2.0.* Culver's root: Signe Danler, © Oregon State University.

Pollinator profile: low-maintenance garden

Three seasons of easy-to-grow plants, both native and non-native, attractive to pollinators

Crocus

	Common name	Scientific name
	Crocus	*Crocus sativus*, spp.
N	**Kinnikinnick, bearberry**	*Arctostaphylos uva-ursi*
N	**Tall Oregon grape**	*Mahonia (Berberis) aquifolium*
	Rosemary	*Rosmarinus officinalis*
N	**Camas spp.**	*Camassia quamash*
	Borage	*Borago officinalis*
N	**Western redbud**	*Cercis occidentalis*

Lavender

	Cockspur hawthorn and spp.	*Crataegus crus-galli and spp*
N	**California lilac**	*Ceanothus 'Victoria', 'Julia Phelps'*
N	**California poppy**	*Eschscholzia californica*
	'Walker's Low' catmint	*Nepeta x faasenii 'Walker's Low'*, cvs.
	Culinary thyme & cvs.	*Thymus vulgaris*, and cvs.
N	**'Cape Blanco' broadleaf stonecrop**	*Sedum spathulifolium 'Cape Blanco'*
N	**Common yarrow**	*Achillea millefolium*
	Lavender	*Lavandula* cvs., spp.
	Pot marigold	*Calendula officinalis*
	Largeflower tickseed	*Coreopsis grandiflora*
N	**Blanketflower**	*Gaillardia x grandiflora, aristata* cvs.
N	**Tufted hairgrass**	*Deschampsia cespitosa*
	'Rozanne' hardy geranium, & cvs.	*Geranium 'Rozanne'*, and cvs.
	Gayfeather, blazingstar	*Liatris spicata*

Bluebeard

	Lamb's ear	*Stachys byzantina*
	Bluebeard	*Caryopteris x clandonensis* and cvs.
	Cosmos	*Cosmos bipinnatus*
	California fuchsia	*Epilobium (Zauschneria) canum* and cvs.
	Sunflower	*Helianthus anuus*
	Russian sage	*Perovskia atriplicifolia*
N	**Black-eyed Susan**	*Rudbeckia hirta*
N	**Canada goldenrod**	*Solidago canadensis*
	'Autumn Joy' stonecrop	*Sedum spectabile 'Autumn Joy'*
N	**Douglas aster**	*Symphyotrichum/Aster subspicatum*

Crocus: © Karen Zimmerman, Oregon State University.
Lavender: © Jennifer Alexander, Oregon State University.
Bluebeard: Signe Danler, © Oregon State University.

N = Northwest native

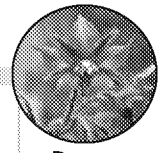
	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
	Pollinators							**Growing conditions**					
Bulb	◆	◆			◆			◆	◆			◆	
Groundcover	◆	◆	◆				◆	◆			◆		
Shrub	◆	◆	◆	◆			◆	◆	◆		◆	◆	◆
Subshrub	◆	◆	◆					◆			◆		
Bulb	◆		◆		◆		◆		◆	◆	◆	◆	
Annual	◆	◆	◆				◆		◆		◆	◆	
Tree	◆	◆	◆	◆	◆		◆	◆	◆		◆	◆	
Tree	◆	◆				◆				◆		◆	◆
Shrub	◆	◆	◆	◆				◆	◆	◆		◆	◆
Annual	◆	◆	◆	◆				◆	◆	◆		◆	
Perennial	◆	◆	◆	◆		◆			◆	◆		◆	
Groundcover	◆	◆	◆	◆		◆			◆	◆		◆	
Perennial			◆	◆		◆		◆	◆	◆		◆	◆
Perennial				◆		◆		◆	◆	◆		◆	◆
Perennial	◆	◆	◆	◆		◆			◆	◆		◆	
Annual	◆	◆	◆	◆		◆				◆		◆	◆
Perennial				◆		◆			◆	◆		◆	
Perennial	◆	◆		◆	◆				◆	◆		◆	
Grass						◆		◆	◆	◆		◆	◆
Perennial				◆		◆				◆		◆	◆
Perennial			◆	◆		◆		◆	◆	◆	◆	◆	
Groundcover	◆	◆	◆					◆	◆		◆		
Shrub	◆	◆						◆	◆		◆		
Annual	◆	◆			◆				◆		◆		
Perennial	◆	◆		◆	◆			◆			◆		
Annual	◆	◆	◆		◆		◆	◆	◆		◆		
Perennial	◆	◆	◆					◆	◆		◆		
Perennial	◆	◆	◆		◆	◆			◆	◆		◆	
Perennial		◆	◆		◆				◆			◆	
Perennial	◆				◆			◆	◆			◆	
Perennial			◆		◆		◆	◆	◆	◆	◆	◆	

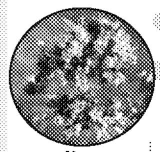
Bloom season and color *Bloom times will vary by location and year.*

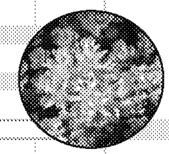
February | March | April | May | June | July | August | September | October | November

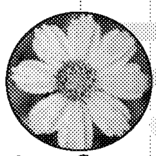
Lighter bars indicate periods of intermittent bloom

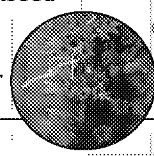

Kinnikinnick

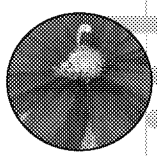

Borage

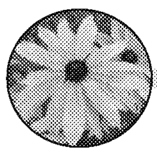

Culinary thyme


Broadleaf stonecrop


Largeflower tickseed


Gayfeather


Cosmos


Black-eyed Susan

Pollinator profile: central and southern Oregon garden

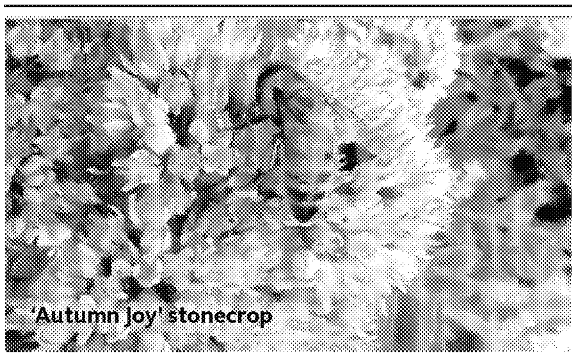
Three seasons of easy-to-grow plants, both native and non-native, attractive to pollinators


Golden currant

	Common name	Scientific name
N	**Western serviceberry**	*Amelanchier alnifolia*, spp.
N	**Kinnikinnick, bearberry**	*Arctostaphylos uva-ursi*
N	**Greenleaf manzanita**	*Arctostaphylos patula*
	'Pink Dawn' viburnum	*Viburnum x bodnantense 'Pink Dawn'*
	Cockspur hawthorne and spp.	*Crataegus crus-galli* and spp.
N	**Tall Oregon grape**	*Mahonia (Berberis) aquifolium*
	Crabapple	*Malus floribunda*
N	**Golden currant**	*Ribes aureum*
N	**Stonecrop**	*Sedum spathulifolium*, spp.
N	**Oregon checkermallow**	*Sidalcea oregona*
N	**Oregon sunshine**	*Eriophyllum lanatum*
	Thyme & cvs	*Thymus vulgari* and cvs.


Rocky Mountain bee plant

	Common name	Scientific name
N	**Common yarrow**	*Achillea millefolium*
	Anise hyssop, hummingbird mint	*Agastache foeniculum* and cvs., spp.
N	**Balsamroot**	*Balsamorhiza sagittata*
N	**Poppy mallow, prairie winecup**	*Callirhoe involucrata*
N	**Rocky Mountain bee plant**	*Cleome serrulata*
N	**Purple coneflower**	*Echinacea purpurea*
N	**Buckwheat**	*Eriogonum* spp.
N	**Sulphur buckwheat**	*Eriogonum umbellatum*
N	**Blanketflower**	*Gaillardia aristata*
N	**Sticky geranium**	*Geranium viscosissimum*
N	**Phacelia**	*Phacelia* spp.
N	**Oceanspray**	*Holodiscus discolor*
	Lavender	*Lavandula* cvs., spp.
	Gayfeather, blazingstar	*Liatris spicata*
	Alyssum	*Lobularia maritima*
	Smooth beardtongue	*Penstemon digitalis 'Husker Red'*, spp.
	Mexican sunflower	*Tithonia* spp.
N	**Mock orange**	*Philadelphus lewisii* and cvs.
	Japanese Tree Lilac	*Syringa reticulata 'Ivory Silk'*


'Autumn Joy' stonecrop

	Common name	Scientific name
	Bluebeard	*Caryopteris* x *clandonensis* and cvs.
	Cosmos	*Cosmos bipinnatus*
	'Walker's Low' catmint	*Nepeta x faasenii 'Walker's Low'*, cvs.
	Zinnia (single-petaled varieties)	*Zinnia* spp.
N	**Black-eyed Susan**	*Rudbeckia hirta*
N	**Canada goldenrod**	*Solidago canadensis*
N	**Green rabbitbrush**	*Chrysothamnus viscidiflorus (lanceolatus)*
	'Autumn Joy' stonecrop	*Sedum spectabile 'Autumn Joy'*
	Aster	*Symphyotrichum/ Aster* spp., cvs.

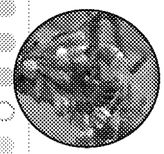
Golden currant: Hans, pixabay.com, *CC0*
Rocky Mountain bee plant: Matt Lavin, *CC 2.0*.
'Autumn Joy' stonecrop: Signe Danler, © Oregon State University

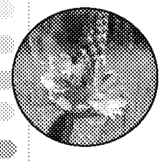
N = Northwest native

	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
	Pollinators							**Growing conditions**					
Shrub	◆		◆		◆		◆		◆	◆	◆	◆	
Groundcover	◆	◆	◆				◆	◆			◆		
Shrub		◆	◆				◆	◆	◆		◆	◆	
Shrub	◆				◆				◆		◆	◆	
Tree	◆				◆				◆		◆	◆	
Shrub	◆	◆	◆	◆			◆	◆	◆		◆	◆	◆
Tree	◆	◆	◆				◆		◆			◆	
Shrub			◆	◆	◆		◆	◆	◆		◆	◆	
Perennial		◆	◆		◆		◆		◆		◆	◆	
Perennial			◆		◆		◆	◆	◆		◆	◆	
Perennial			◆		◆	◆	◆	◆	◆		◆	◆	
Groundcover	◆	◆	◆		◆			◆	◆		◆		

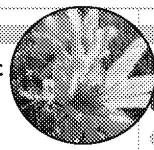
Bloom season and color *Bloom times will vary by location and year.*

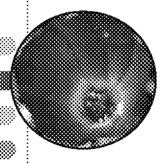
Spring | Summer | Fall

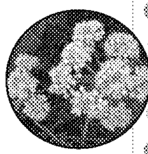

'Pink Dawn' viburnum

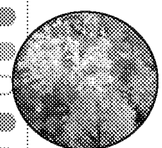

Oregon checkermallow

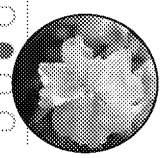
	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
Perennial			◆		◆		◆	◆	◆		◆	◆	
Perennial	◆	◆	◆	◆	◆			◆	◆		◆		
Perennial			◆		◆		◆	◆			◆	◆	
Perennial			◆		◆		◆	◆	◆		◆	◆	
Annual	◆	◆	◆	◆	◆			◆	◆	◆	◆		
Perennial	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆		
Perennial	◆	◆	◆				◆	◆			◆		
Perennial		◆	◆		◆		◆	◆			◆		
Perennial			◆		◆		◆	◆	◆		◆		
Perennial			◆		◆			◆			◆		
Ann./perennial		◆	◆		◆			◆	◆		◆	◆	
Shrub		◆	◆		◆		◆	◆	◆		◆	◆	
Perennial	◆	◆	◆		◆			◆	◆		◆		
Perennial		◆	◆		◆		◆		◆	◆	◆		
Annual			◆		◆				◆			◆	
Perennial	◆	◆	◆	◆	◆				◆			◆	
Annual	◆	◆	◆	◆	◆			◆	◆		◆		
Shrub	◆	◆	◆	◆	◆		◆		◆			◆	
Tree	◆		◆		◆				◆		◆	◆	


Balsamroot

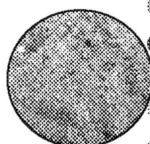

Poppy mallow

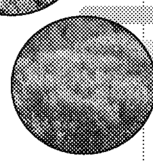

Sulphur buckwheat


Oceanspray


Mock orange

	Honey bees	Bumble bees	Native bees	Hummingbirds	Butterflies	Moths	Larval hosts	Dry	Some water	Moist	Full sun	Part sun	Shade
Shrub	◆	◆						◆	◆		◆		
Annual	◆	◆			◆				◆		◆		
Perennial	◆	◆	◆		◆			◆	◆		◆		
Annual		◆		◆	◆			◆	◆		◆		
Perennial	◆	◆	◆		◆	◆			◆	◆		◆	
Perennial		◆	◆		◆				◆			◆	
Shrub	◆		◆		◆			◆			◆		
Perennial	◆				◆			◆	◆			◆	
Perennial			◆		◆		◆		◆		◆	◆	


Walker's Low catmint


Green rabbitbrush

'Pink Dawn' viburnum: Amy Jo Detweiler, © Oregon State University; *Oregon checkermallow*: Maysa Miller, Bureau of Land Management, *CC BY 2.0*; Balsamroot: Lynn Ketchum, © Oregon State University; *Poppy mallow*: Jacopo Werther, *CC2.0*. Sulphur buckwheat: © 2013 Jean Pawek. Oceanspray: Dave Powell, USDA Forest Service, bugwood.org; Mock orange: Elizabeth Lindhag, *CC0*. Bluebeard: © Signe Danler, Oregon State University. *Green rabbitbrush*: Jacopo Werther, *CC2.0*.

PART 2

How to control invasive pests

– while protecting pollinators and other beneficial insects

Don't apply pesticides unless they are necessary to maintain plant health. Using preventive sprays, where pesticides are sprayed several times a year on a calendar basis, has been shown to create more pest problems than it solves. Cover sprays create the potential for pesticide runoff and increased exposure to people and pets. What's more, cover sprays actually create pest problems by suppressing predators, parasitoids and diseases that keep plant pests under control.

It is not unusual to observe outbreaks of spider mites, aphids and scale insects where pesticides are used. A few exceptions to this rule include the use of many fungicides, which are often applied prior to the occurrence of disease, and treatments such as horticultural oils that are applied when plants are dormant.

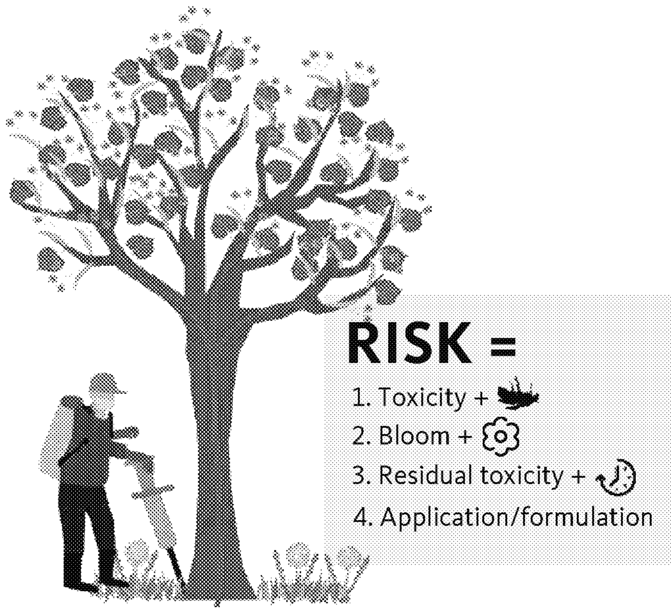
In many cases, the cause of a plant problem may have nothing to do with an insect pest or disease, but rather improper siting, or too little or excessive watering. Before using pesticides, it is critical to diagnose the problem:

- Which specific pest or disease, if any, is causing the problem?
- Is there really a problem? Is the damage to a plant superficial, or is it likely to clear up on its own?
- Are there effective and cost-effective nonchemical methods to control the pest or disease?

The recommendations that follow assume you have already examined the problem thoroughly and determined that a pesticide is necessary.

What increases the risk pesticides pose to pollinators?

The hazard a pesticide treatment poses to pollinators is not only a function of the toxicity of the product, but also of the way that it is applied.



Graphic: Iris Kormann, © Oregon State University

Figure 14. Risk to pollinating insects

The risk a pesticide poses to pollinating insects is more than the question of whether a product is toxic to the insects. We must also consider whether the target area contains flowers attractive to pollinators, the length of time the pesticide remains toxic (known as the residual time) and the way a pesticide is applied or formulated.

One important factor in risk to bees is whether the treated area has pollinator-attractive flowers. Take, for example, a linden shade tree (Figure 14). The risk of the treatment increases as soon as this linden tree is in bloom, because bees will be actively visiting the tree trying to collect nectar. But bloom does not include just the plants you are targeting. Say, for example, pollinator-attractive weeds such as dandelions grow underneath the tree. If a toxic product covers these flowers, the risk to pollinators is greatly elevated.

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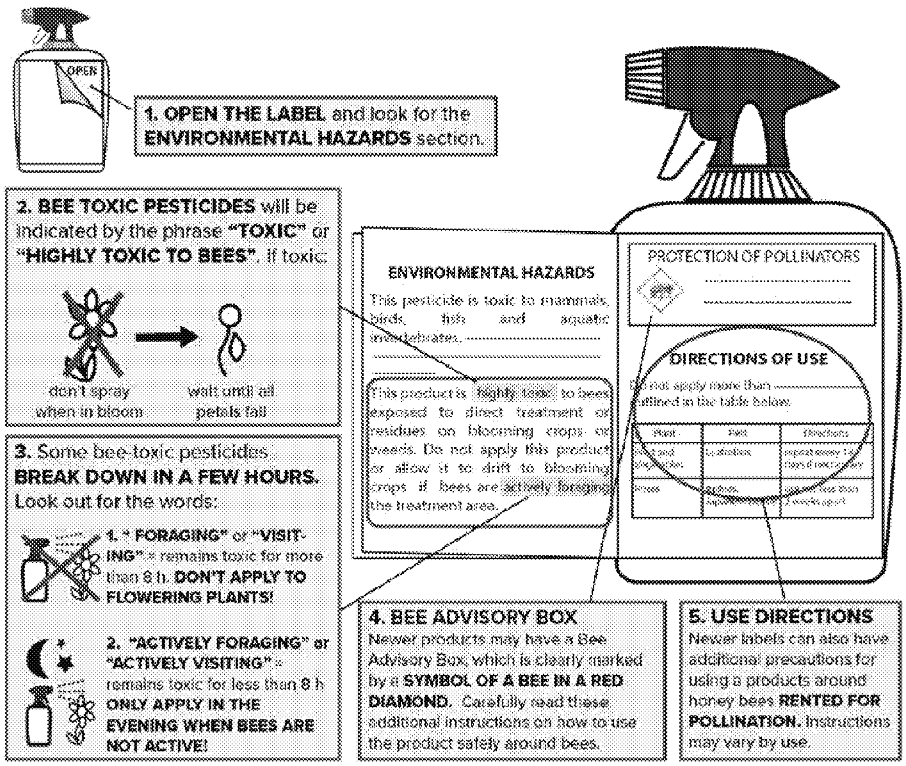
The next factor that increases the risk of a product is the residual time of the pesticide, or how long a pesticide remains toxic to bees after it is applied. A key aspect of bee biology is that individuals go back to their nest at night. They do not visit flowers at night. If you apply a product at dusk and the product breaks down overnight, the risk to the bees is greatly reduced when they fly again the next morning.

Finally, risk has to do with the formulation and application methods you use. Certain application methods, like some soil-drench products for controlling insect pests on shade trees, move right through the tree into the blossoms, causing pollinators to be exposed to the pesticide, even though the products were not directly applied to flowers. Some soil-drench applications have also been shown to be very persistent in woody ornamentals and can end up in nectar and pollen at concentrations toxic to bees, even if applied months before bloom. The same products applied directly to the leaves of the woody ornamental can be far less persistent.

Figure 16. How to read a pesticide label

Pesticide labels provide key information on how and when to use a product to avoid exposure to pollinators. Information may be located on several parts of the label. Cards that interpret information on labels are available through the Oregon Bee Project.



Graphic: Iris Kormann and Andony Melathopoulos, © Oregon State University

Reading labels: Don't judge a pesticide label by its cover

Selecting a pesticide from a store shelf can be a confusing process. As an example, a product in a green bottle may appear safer than another product in a red bottle (Figure 15). The front of a pesticide container does not provide enough information. You need to determine:

- Whether a product can be used on the plant you want to treat.
- Whether it is effective against the pest you want to control.
- How to use it safely around pollinators.

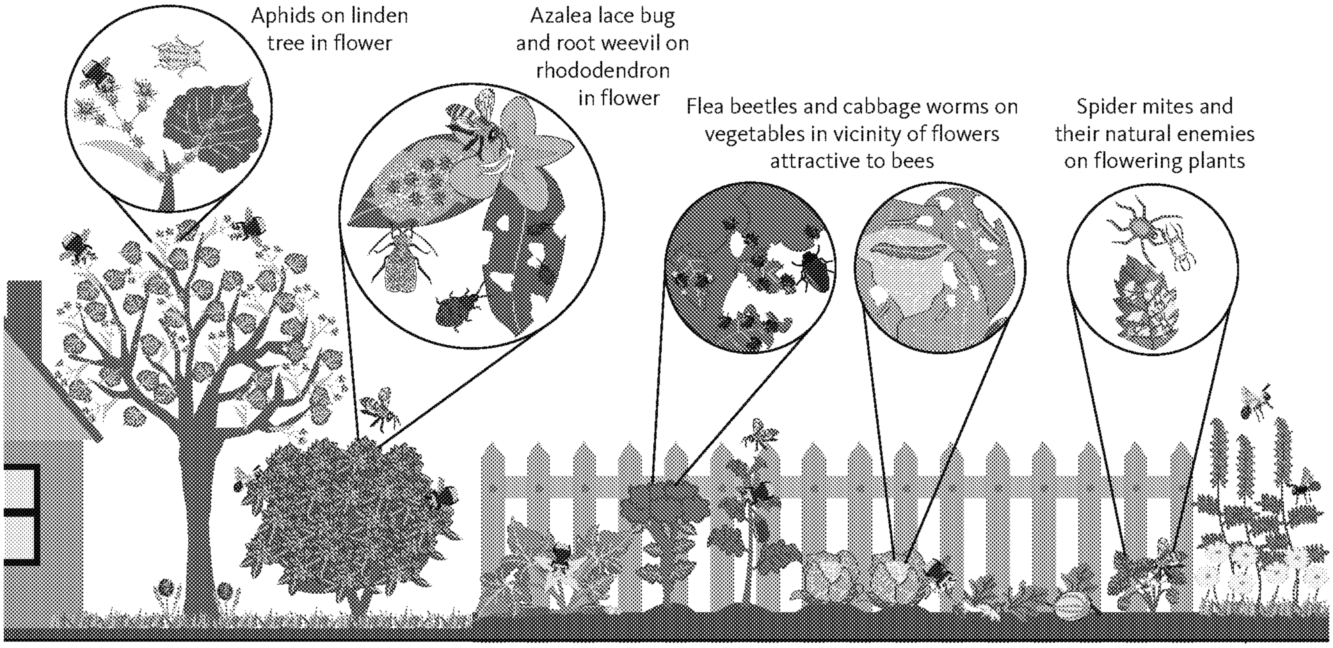
To gain this information, you need to open the label on the back of the bottle. Typically, the first two pieces of information can be found on an area of the label titled General Use Directions and Specific Use Directions. In addition, sections of the label tell you how to use the product to ensure your own safety.

Information on how to use the product safely around pollinators is listed on specific regions of the label (Figure 16). These sections indicate whether a product can be used on bee-attractive plants in bloom and whether its use needs to be restricted to evening treatments. The amount of information on a pesticide label can be overwhelming. Here are three practices that can help.

Figure 15. Pesticide labeling

These insecticide products are equally toxic to bees.

Graphic: Iris Kormann, © Oregon State University



Graphic: Iris Kormann, © Oregon State University

Figure 17. Where pest control collides with protection of beneficial insects like pollinators in the garden

Pollinators visit many of the same plants that attract insect pests. Avoid applying pesticides to plants whose flowers attract bees.

3 tips for reducing pollinator exposure to pesticides

You can avoid the use of pesticides — particularly insecticides — in urban landscapes by selecting plants that are not prone to pest and disease problems. Use pesticides only as a last resort. If a pesticide treatment is required, the following practices will help reduce pesticide exposure to insect pollinators:

DON'T spray during bloom

1 If you have to apply a pesticide treatment to a bee-attractive plant, wait until the petals have dropped. Even though some products may indicate that they are not toxic to bees, or that residues left on the plant will break down overnight, it is best to exercise caution and conduct pest control outside of the blooming window. For one thing, studies provided to inform pesticide label language are not conducted for all pollinator species; they typically apply only to honey bees. In many cases, the studies focus on doses that kill the bee; sublethal effects, such as reduced foraging capacity or increased susceptibility to diseases, are not a subject of study. You can reduce the uncertainty associated with the effects on pollinating insects by treating pollinator-attractive plants before or after they bloom.

DON'T allow spray to drift onto blooming weeds

2 Before applying a pesticide treatment, mow all weeds, such as dandelions, that may be attractive to bees. Be mindful that other plants surrounding the plant you are treating may be attracting bees. Also, some plants that you might not consider to be pollinator plants, such as squash or strawberries, are attractive to pollinators and should not be treated during bloom (Figure 17).

DON'T use soil drenches or tree trunk injections

3 Some insecticides, particularly those in the neonicotinoid group, can appear in the nectar and pollen of flowers for over a year after being applied to the trunk or roots of bee-attractive shade trees or woody ornamentals. Don't apply these treatments to bee-attractive shrubs and trees. In Oregon, four neonicotinoids (dinotefuran, clothianidin, imidacloprid and thiamethoxam) are not permitted for use on linden trees at any time (even as foliar sprays).

Avoid spraying flowers with fungicides

Insecticides pose the highest risk to pollinators. Other pesticides, such as herbicides, are of relatively low toxicity to pollinators, although they do kill the plants that pollinators depend on. At one time, most fungicides were thought to be harmless to honey bees, mason bees, bumble bees and other pollinators. In fact, very few fungicides carry hazard statements for pollinators on their labels. Nevertheless, emerging research from agricultural uses of fungicides indicates that excessive fungicide use has a negative impact on multiple species, including honey bees, bumble bees and mason bees. This may occur either by interfering with beneficial fungi associated with these species, or by increasing the toxicity of insecticides that are otherwise of low risk to pollinators (as in the cases of acetamiprid and chlorantraniliprole). Never apply fungicides with insecticides to pollinator-attractive plants in bloom. If possible, restrict fungicide treatments outside of bloom periods, or apply in the evenings to ensure residues are fully dry before pollinators begin foraging.

Best practices for controlling pests and diseases on shrubs and trees

Most pesticide applications by landscape and tree care professionals are the result of a few exotic pests. Because our local ornamental shrubs and trees may lack natural resistance to these invasive pests and we do not have the right species of predators and parasitoids to keep them under control, good cultural practices may not be enough to save the trees and shrubs they attack.

If a damaging invasive pest species will be difficult to control, consider replacing the shrub or tree with one that lacks the same pest pressure and that maintains high value for pollinators. Or, follow these best management practices for each invasive pest. These practices are designed to save the infested tree or shrub while minimizing the harmful effects of pesticides on pollinators and other beneficial insects. Each section starts with a summary of the importance of the host tree or shrub as a food source for pollinators or beneficial insects. It's critical to follow best practices in the case of trees and shrubs that are important food plants for pollinators.

Stress reduction

In general, stressed shrubs and trees experience higher levels of pest problems. Many of these problems can be significantly reduced during plant establishment. Ensure it starts with good drainage by planting it in a hole that is neither too shallow nor too deep. If a tree needs staking, stake it in a manner that allows movement but does not result in injuries to the bark.

When the tree or shrub is growing, ensure that pruning is correctly performed, and does not invite wood decay. Make sure soil around the roots is not compacted. Use herbicides carefully, making sure not to damage the plant. Don't use excessive fertilizer, which will encourage aphids and scale.

Apple scab on crabapples

Best management: Protecting susceptible crabapple trees from apple scab without harming pollinators requires carefully timed sprays of fungicides. Gradually replacing susceptible crabapples with resistant varieties, or another type of tree, is the best long-term strategy. The problem is that several commonly used fungicides can be toxic to bee larvae when they are fed tainted pollen. Avoid using captan, ziram, iprodione, chlorothalonil and mancozeb when trees are in bloom, and during the last week before the flowers open. Other fungicides may not be as harmful to pollinators, but can still inhibit the beneficial fungi that ferment bee bread in honey bee hives. Unfortunately, fungicide sprays to prevent apple scab are usually recommended to be applied between green tip (just before the leaves open) and petal fall, which includes the time when flowers are open. The best schedule to protect trees while minimizing impacts on pollinators is to spray when leaves begin to open, before the first flowers open. Then spray again when the flowers are done blooming and the petals fall off. This is the best schedule for pollinators regardless of which fungicide is used. Still, it is best to avoid using the fungicides listed above that are known to be harmful to bees before the flowers open. After petal fall they are unlikely to affect bees, unless the spray drifts onto the flowers of nearby trees and shrubs, or onto perennials, wildflowers or flowering weeds below the trees.

Azalea lace bug on azaleas and rhododendrons

Importance to pollinators: Azaleas and rhododendrons vary in their attractiveness to bees, although some varieties are exceptional sources of pollen and nectar.

Invasive pest: Azalea lace bug (*Stephanitis pyrioides*)

Best management: Azalea lace bug was detected in Washington state in 2008 and in Oregon in 2009. The bugs can cause severe damage to azaleas and rhododendrons, turning the leaves nearly white. Heavily damaged leaves are desiccated and turn brown, and severe damage may defoliate the plant. Azalea lace bug feeds on both evergreen and deciduous azaleas and rhododendrons. Least toxic controls may include insecticidal soap, horticultural oil, and microbial- and botanically based products.

Other chemical options include contact insecticides such as the pyrethroids or carbaryl, or systemic insecticides such as acephate or the neonicotinoids. These can be highly toxic to bees and other beneficial insects. Even though rhododendrons and azaleas are not as attractive as some other plants to pollinators, take care not to apply pesticides while pollinators are present, or not to use pesticides at all.

One effective, nontoxic method of azalea lace bug control is to spray the undersides of the leaves regularly with a strong jet of water to dislodge and kill delicate adults and nymphs. Start this in May, when eggs first hatch, and continue into at least July. This can greatly reduce the population for the next year.

Bronze birch borer on European white birch

Importance to pollinators: Although birch (*Betula pendula*) is a wind-pollinated tree, the spring catkins produce a lot of pollen that may be collected by bees.

Invasive pest: Bronze birch borer (*Agrilus anxius*).

Best management: The best option is to grow species of birch native to North America because they are resistant to bronze birch borer. However, many garden centers still carry European white birch, *Betula pendula*, which is susceptible to bronze birch borer. In fact, European white birch trees are likely to die within 20 years of when they are planted due to borer injury.

The standard practice to preserve European white birch trees is to use a trunk injection of emamectin benzoate every third year, or a trunk injection or soil drench of imidacloprid each year. Trunk injections should be made in late May after birch trees are done flowering. We do not know how much, if any, insecticide will remain in the pollen the following year. Basal soil drenches of imidacloprid or dinotefuran, applied after flowering, protect birch trees while minimizing the impact on pollinators the following year. Dinotefuran is less likely than imidacloprid to persist into the next year.

Emerald ash borer on ash trees

Importance to pollinators: Ash trees (*Fraxinus* spp.) can be an important source of pollen for bees during a two-week period in early spring when they bloom. Ash trees do not produce nectar.

Invasive pest: Emerald ash borer (*Agrilus planipennis*, not currently in the Pacific Northwest, but spreading westward)

Best management: Emerald ash borer is steadily spreading throughout all of the eastern United States and into some Western states. It is killing all the ash trees in forests, woodlots and managed landscapes. Insecticides are available to homeowners and professionals that will preserve individual trees, but all of these insecticides are potentially toxic to pollinators and beneficial insects. Because ash trees flower in early spring, pesticide movement into pollen can be minimized by waiting until ash trees are finished flowering (mid- to late May) before applying a basal soil drench or making a trunk injection. We do not have adequate data on the amount of systemic pesticide that will move into ash pollen one year after application. But treating ash trees after they are done flowering will minimize the impact on pollinators the following year. Dinotefuran usually does not persist in treated trees as long as imidacloprid, and therefore is less likely to appear in pollen the following spring. The same principle applies to dinotefuran and imidacloprid applied as a basal soil drench, trunk injection or bark spray. Emamectin benzoate persists for at least two years following a trunk injection, but no data are available at this time on how much, if any, emamectin benzoate moves into pollen. Watch for updates on pollinator impacts from treating ash trees for emerald ash borer as more research on this topic is completed. Currently, there are no insecticide products that are effective against emerald ash borer that are also not potentially harmful to bees.

Euonymus scale on evergreen euonymus, pachysandra and bittersweet

Importance to pollinators: Euonymus (*Euonymus* spp.), pachysandra (*Pachysandra* spp.) and bittersweet (*Celastrus* spp.) pollen can be collected by bees, but they are not considered an important source of pollen.

Invasive pest: Euonymus scale (*Unaspis euonymi*).

Best management: Susceptible types of euonymus are almost guaranteed to become infested with euonymus scale. Plants decline slowly and become thin and unsightly. Hand-wipe to help control small infestations, when practical. Prune out heavily infested branches. Apply doublestick tape around or near infestations of adult scale to catch the crawler stage. As with aphids, avoid excessive nitrogen fertilizer, as this favors population increase. The most effective insecticide treatments for euonymus scale are an insect growth regulator (Pyriproxyfen) or horticultural oil applied as a foliar spray during crawler emergence in late spring. Pyriproxyfen is not harmful to adult bees or butterflies, but it is not known if it affects bee larvae fed with tainted pollen. A 2% concentration of horticultural oil applied during crawler emergence is the safest treatment for pollinators. Avoid spraying when bees are present.

Japanese beetle on roses, lindens, raspberries, blueberries, birch and many others

Importance to pollinators: Hybrid tea roses, rugosa roses and the popular Knockout roses are weak nectar and pollen producers. In a survey in Colorado, most *Rosa* spp. in gardens were observed to be "rarely visited by bees," but a few rose plants were "frequently visited by bees." Linden trees (*Tilia* spp.), birch trees (*Betula* spp.), raspberries (*Rubus* spp.) and blueberries (*Vaccinium* spp.) are highly attractive to bees.

Invasive pest: Japanese beetle (*Popillia japonica*), currently restricted to Portland area in Oregon.

Best management: Rugosa rose foliage is not skeletonized by Japanese beetles, but the beetles may feed on flowers. Flower feeding on rugosa roses is not nearly as much of a problem as it is on hybrid tea roses. Standard insecticide sprays used to protect hybrid tea roses (carbaryl, bifenthrin, cyfluthrin and other pyrethroids) are highly toxic to pollinators and other beneficial insects. Chlorantraniliprole is an alternative insecticide that provides good control of Japanese beetles as a foliar spray, but is much less toxic to bees.

Linden aphid on lindens/ tuliptree aphid on tuliptree

Importance to pollinators: Linden trees (*Tilia* spp.) and tulip trees (*Liriodendron tulipifera*) are both highly attractive to honey bees and bumble bees in midsummer.

Invasive pests: Linden aphid (*Eucallipterus tiliae*) and tuliptree aphid (*Macrosiphum liriodendri*)

Best management: Aphids rarely damage the tree, causing only minor leaf and shoot distortions. But the aphids produce large amounts of honeydew, a sticky liquid that can spot cars and walkways. Trees that are out of the way of parked cars and frequently used walkways can be left untreated. Aphid pressure can be reduced by not overfertilizing trees and avoiding drought stress by regularly watering and maintaining a mulched zone around the tree's root zone. Insecticidal soaps can be used to control the aphids, but should only be applied between dusk and dawn during bloom. Researchers are currently evaluating systemic tree injections with azadiractin or chlorantraniliprole as aphid control alternatives to neonicotinoids, which have high toxicity to bees. In Oregon, four neonicotinoids cannot be used on lindens (dinotefuran, imidacloprid, thiamethoxam and clothianidin) because of high toxicity to bees.

Viburnum leaf beetle on viburnum

Importance to pollinators: Viburnum (*Viburnum* spp.) flowers are often described as attractive to bees. Some types of viburnum may be more attractive than others. *Viburnum plicatum* and *Viburnum davidii* are attractive to bees.

Invasive pest: Viburnum leaf beetle (*Pyrrhalta viburni*, currently restricted to northwest Washington in the Pacific Northwest)

Best management: Viburnum leaf beetle adults and larvae are active from late spring to early summer. Because of a lack of natural enemies, extensive feeding injury can defoliate viburnum shrubs. Prune out egg-infested twigs during the winter months. Hand-pick and kill emerging larvae and apply sticky barrier on the trunk to trap and kill mature larvae as they migrate down the bush. Avoid spraying when viburnum plants are flowering, or use chlorantraniliprole during bloom to minimize impact on pollinators. An insecticide applied after the flowering period is over will not harm bees unless there is some drift to nearby flowering weeds or perennial flowers.

Better pesticides to use around pollinators

Insecticides are the most toxic group of pesticides to pollinators. This section outlines less toxic options for managing pests. Many of these products are available for homeowners, although in some cases they may require a pesticide license. Products that require a pesticide license prior to purchase are known as restricted-use pesticides.

Use low-impact pesticides

Low-impact pesticides protect pollinators in different ways. Some selectively target only one type of insect, so they are less likely to harm others. Some break down rapidly after they are applied. However, using these products requires some knowledge about their relative toxicity to beneficial insects and their potential to cause leaf or flower injury, which is known as phytotoxicity. The following types of products have little or low impact on beneficial insects.

Insecticidal soaps

Insecticidal soaps sprayed on plant leaves are effective on a wide range of pests when the soap spray comes into contact with the pest. Most commercially available insecticidal soaps are made of potassium salts of fatty acids and kill by disrupting the structure and permeability of insect cell membranes. Insecticidal soaps are most effective on soft-bodied insects such as aphids, adelgids, lace bugs, leafhoppers, mealybugs, thrips, sawfly larvae, spider mites and whiteflies. They are not effective on pests as a residue on the plant surface, and therefore are not toxic to pollinators after the spray dries. They can be safely used at any time to control pests on plants that are not attractive to pollinators. On pollinator-attractive plants, spray at dawn or dusk when pollinators are not present.

Concentrations of insecticidal soaps exceeding 3% may cause some leaf or flower injury, and concentrations as low as 1.5% may injure sensitive plants. Read the product label for a list of sensitive plants and avoid spraying those. If uncertain of a plant's sensitivity, spray a few leaves or flowers first and wait at least three days to watch for symptoms of spray injury, which include yellow, black or brown spots, brown (necrotic) edges on leaf and petal tips, scorch or discoloration. Some landscape plants known to be sensitive to insecticidal soap are horse chestnut, mountain ash, Japanese maple, sweet gum, jade plant, lantana, gardenia, bleeding heart, sweet peas, crown-of-thorns and some cultivars of azalea, begonia, chrysanthemum, fuchsia and impatiens.

Purchase a commercial product formulated for use on plants; homemade recipes may be more toxic to plants. Most insecticidal soap products are detergents rather than true soaps, which can damage your plants. Only use products that are specifically formulated and labeled for use as an insecticide. Many insecticidal soaps are listed by the Organic Materials Review Institute at omri.org.

Horticultural oils

Horticultural oil is a term for the various oils used for pest control on plants. Most horticultural oils are lightweight and petroleum-based, but some are made from grains, vegetables or neem tree seeds. Like insecticidal soap, horticultural oils work best when the spray comes in contact with the pest. Once the oil spray dries, it does not have much effect and becomes safe for pollinators and other beneficial insects.

Horticultural oils give excellent control of armored scales, such as Euonymus scale and oystershell scale, and can also be used for aphids, whiteflies, spider mites, true bugs, caterpillar, sawfly larvae and more. The recommended concentration of horticultural oils for pest control is usually 2%. However, even at 2%, some plants are sensitive to oils, including maple, walnut and plum. Plants reported as somewhat sensitive are spruce, redbud, juniper, cedar, cryptomeria and Douglas-fir. Applying oils during high humidity or high temperatures may have a toxic effect on plant growth. Symptoms of injury include discoloration, yellowing, leaf or flower browning (necrosis), black spots and terminal or branch dieback. Spray a few plants first and observe them for three days for these phytotoxicity symptoms. OMRI lists many horticultural oil products.

Microbial or biopesticides

Several pesticides are derived from naturally occurring pathogens such as bacteria or fungi. These microbial or biopesticides vary in their toxicity to bees, butterflies and other beneficial insects. Some bioinsecticides, such as those derived from the fungus *Beauvaria bassiana*, are toxic to bees and should not be used where pollinators are present. Other bioinsecticides may have low impact on pollinators due to their low toxicity or short residual time, which allows them to be applied in the evening or at dawn when bees are inactive.

The following biopesticide active ingredients are found in products that are toxic to specific groups of insects, while being harmless to others.

Bacillus thuringiensis (B.t.)

Products containing B.t. are made from a naturally occurring soil bacterium. Many different B.t. products are available for landscape professionals and homeowners. Different strains of B.t. target specific pest groups, making them selective pesticides. For example, spores and crystals of *Bacillus thuringiensis* var. *kurstaki* (B.t.k.) are highly toxic when ingested by the caterpillars of pest butterflies and moths. The crystals containing the toxin dissolve only at an extremely high pH found in the caterpillar's gut. Consequently, while B.t.k. is not toxic to bees, it can pose a risk to nonpest butterfly and moth populations. Avoid spraying or allowing spray to drift onto plants favored by caterpillars, such as milkweed, the sole food source for monarch butterfly caterpillars.

While a B.t. strain works well for its target pest, it also breaks down quickly in sunlight, becoming ineffective after a few days. This makes B.t. safe for pollinators, predatory insects and mammals. B.t. can be sprayed even when bees or butterflies are present. OMRI lists many B.t. products.

Metarhizium

Metarhizium anisopliae is a fungus found naturally in soils that infects and kills insects. Commercially available products of *M. anisopliae* (Met52, for example) target thrips, weevils, whiteflies and mites on ornamentals, and ticks in turf. Once the product is sprayed on the foliage or drenched in the soil, the spores attach to the surface of the insect, germinate and penetrate the insect, then multiply and kill it. *M. anisopliae* has no detrimental effect on honey bees and is being studied as a bioinsecticide of Varroa mites, a pest of honey bees. The product is not suitable for use where water could be contaminated.

Chromobacterium subtsugae

This naturally occurring bacterium is used in a fermentation process that produces a product with insecticidal properties. (Grandevo PTO is one example.) It is a broad-spectrum bioinsecticide/miticide that controls or suppresses insect and mite pests on ornamentals and turf. It has multiple modes of action, including oral toxicity (stomach poison), repellency and reduced reproduction. This product is sprayed on leaves and targets numerous caterpillar species in addition to aphids, whiteflies, thrips, psyllids, lace bugs, chinch bugs, mites and certain beetles. It suppresses a broad number of caterpillar species and should not be sprayed or allowed to drift in known habitats for threatened or endangered species of caterpillars and butterflies. This product may repel bees for up to six days, so time applications to avoid disrupting pollination. Grandevo PTO (active ingredient *C. subtsugae*) is an OMRI-listed product.

Azadirachtin

Azadirachtin is the active ingredient extracted from seeds of the tropical neem tree. Bioinsecticides with azadirachtin act in three ways: as an insect growth regulator, as an antifeedant (it causes insects to lose their appetite for feeding on the plant) and as a repellent to insects. It is effective at controlling immature stages of insects and is broadly labeled for adelgids; aphids; caterpillars such as budworms, tent caterpillars and webworms; beetles such as Japanese beetles, emerald ash borers, weevils and elm leaf beetles; leafhoppers; leafminers; mealybugs; psyllids; sawflies; scales; thrips; and whiteflies. Azadirachtin must be ingested to be toxic. When applied as a foliar spray, it has short residual activity, making it unlikely bees and other pollinators will be affected. (It is no longer toxic after about two hours for bees.) Direct contact has shown no effect on worker honey bees. Azadirachtin products can be safely used at any time to control pests on plants that are not attractive to pollinators. However, on pollinator-attractive plants they should be sprayed during late evening, at night or in early morning. Spraying at times when pollinators are not present will minimize contact with adult bees that could potentially bring azadirachtin back to the nest where larvae are present. Many azadirachtin products are OMRI listed.

Spinosad

Spinosad is derived from a soil bacterium and affects the nervous system of insects and mites. It has contact activity but is even more active when ingested. Several products containing spinosad, such as Conserve, are labeled for ornamental and agricultural uses to control a broad spectrum of pests including caterpillars, sawfly larvae, leaf beetle adults and larvae, thrips, leafminer, gall-making flies and emerald ash borer beetles. Spinosad is highly toxic to bees. However, toxicity is greatly reduced once the product has dried on the foliage, within three hours to one day depending on the product. Avoid use if bees are active. If you need to use it, apply in the evening when bees are not active and the product has time to dry. This product suppresses a broad number of caterpillar species and should not be sprayed or allowed to drift into habitats for threatened or endangered species of caterpillars and butterflies. Some spinosad products are OMRI listed and on the Environmental Protection Agency Reduced Risk list.

Use EPA reduced-risk products

In 1994, EPA established the Reduced Risk Pesticide Program to expedite review and approval of conventional pesticides that pose less risk to human health and the environment than existing pesticides. (See *www.epa.gov/pesticide-registration/reduced-risk-and-organophosphate-alternative-decisions-conventional*.)

Reduced-risk status is granted to products demonstrating one or more of the following attributes:

- Low impact on human health.
- Lower toxicity to nontarget organisms.
- Low potential for ground and surface water contamination.
- Low use rates.
- Low pest-resistance potential.
- Compatibility with IPM practices.

The following active ingredients are found in products on the EPA reduced-risk list and should have minimal impact on bees and other beneficial insects.

Chlorantraniliprole

This chemical interrupts the normal muscle contraction of insects, resulting in paralysis and death. It has limited systemic activity, meaning that it moves internally within the plant. Chlorantraniliprole can be applied as a foliar spray or through the soil. It is labeled against turf pests, including caterpillars, white grubs, crane flies, billbugs, annual bluegrass weevils and spittlebugs; ornamental pests, including leaf-feeding caterpillars, lace bugs, aphids and birch leafminers; and as a bark spray for clearwing borers. Due to the activity of chlorantraniliprole against caterpillars and its long residual activity, it should not be used on larval host plants of butterfly and moth pollinators. Chlorantraniliprole has negligible toxicity to bees, and is shown to have no impact on bumble bees. It has no direct impact on natural enemies, and so is compatible with IPM programs. However, chlorantraniliprole is highly toxic to larval bees when mixed with fungicides containing propiconazole or iprodione.

Acetamiprid

This neonicotinoid kills insects by disrupting the nerve function. Acetamiprid is systemic and absorbed through the foliage or through the bark when applied as a basal bark spray. It is labeled to control a broad range of pest insects on ornamental plants including aphids, adelgids, caterpillars, European pine sawflies, mealybugs, leafhoppers, armored and soft scales, plant bugs, whiteflies, fungus gnat larvae, thrips and leafmining flies. Because acetamiprid is toxic to multiple caterpillar species, this product should not be sprayed or allowed to drift into known habitats for threatened or endangered species of caterpillars and butterflies.

Although acetamiprid is less toxic to bees than other neonicotinoids, it is still toxic to bees directly exposed to the chemical. As the label indicates, if you must apply acetamiprid during bloom, do so at dusk when bees are not visiting blooming plants. When the fungicide fenbuconazole is combined with acetamiprid, the mixture is about five times more toxic to honey bees than acetamiprid alone.

Pyriproxyfen

Pyriproxyfen acts as an insect growth regulator, disrupting the molting process of immature insects. It has translaminar activity, meaning that it moves through the leaves and kills insect eggs. Pyriproxyfen provides good control of certain scale insects including black scale, California red scale, euonymus scale, Florida wax scale, San Jose scale and snow scale. It also controls spotted tentiform leafminer and whiteflies, and suppresses aphids and mealybugs. Pyriproxyfen has low to moderate toxicity to bees. Avoid spraying or allowing drift onto blooming plants attractive to bees. There should be little impact on butterflies or other beneficial insects. Phytotoxicity has been observed on the following plants: salvia (*Salvia* spp.), ghost plant (*Graptopetalum paraguayense*), gardenia (*Gardenia* spp.) and coral bells (*Heuchera sanguinea*).

Pymetrozine

This pesticide disrupts the normal feeding behavior of aphids and whiteflies on ornamentals. The Endeavor label (active ingredient pymetrozine) states no precautions for honey bees and bumble bees. However, some toxicity has been observed in field studies. Apply pymetrozine in the evening, night or early morning when bees are not visiting blooming plants. Since this product is selective for aphids and whiteflies, there should be no impact on other pollinators or natural enemies.

Spiromesifen

Spiromesifen is a mite growth regulator. It is a lipid biosynthesis inhibitor and targets all stages of a broad range of mite species, including spider, false spider, rust and tarsonemid mites, and immature stages of whitefly species. The Forbid label (active ingredient spiromesifen) states no precautions for bees, but there are concerns about the systemic nature of this product and the potential exposure of bee larvae to this class of insecticide. Due to this concern, spiromesifen should be applied after bloom for flowering plants attractive to bees.

Acequinocyl

This miticide is a metabolic poison that kills spider mites by affecting energy production. It provides quick knockdown and long residual control for spruce spider mites and twospotted spider mites. Plants should be tested for sensitivity to acequinocyl, especially roses and impatiens. The Shuttle label (active ingredient acequinocyl) states no precautions for bees. Acequinocyl is considered nontoxic to bees and can be applied at any time. Since acequinocyl is selective for mites, other pollinators and natural enemies should not be affected.

Flupyradifurone

This novel butenolide kills insects by disrupting nerve function. Flupyradifurone, marketed as Altus, is systemic and can be applied as a foliar spray or soil drench. It is labeled to control a broad range of sucking insects on ornamental plants, including aphids, lace bugs, scales, leafhoppers, psyllids, mealybugs and whiteflies. Flupyradifurone is compatible with many beneficials and has no adverse effects on honey bees and bumble bees. It can be applied before, during and after bloom. It is compatible with IPM programs.

Low-impact miticides not on the EPA reduced-risk list

Hexythiazox

This growth regulator disrupts the normal development of mites. It is effective against immature spider mites and eggs, has long residual activity and is applied at low rates. Hexygon (active ingredient hexythiazox) is selective for spider mites in the Tetranychidae family, which includes arborvitae spider mites, European red mites, honeylocust spider mites, Pacific spider mites, Southern red mites, spruce spider mites, strawberry spider mites, twospotted spider mites and Willamette mites. There is no bee precautionary statement on the Hexygon label, and it is generally considered nontoxic to bees, although there is a caution there may be a short residual effect (about two hours) on alfalfa leafcutting and alkali bees. As a caution, apply hexythiazox in the evening, night or early morning when bees are not visiting blooming plants. Since hexythiazox is selective for mites, other pollinators and natural enemies should not be affected.

Buprofezin

Buprofezin is an insect growth regulator effective against nymphal stages of soft and armored scales (crawler stage), whiteflies, psyllids, mealybugs, planthoppers and leafhoppers. It works by inhibiting chitin synthesis, suppressing oviposition of adults and reducing egg viability. It is nontoxic to bees and is not disruptive to other beneficial insects and mites.

Etoxazole

Etoxazole is a selective miticide effective against most plant-feeding mites, but fairly safe for most predatory insects and mites. Etoxazole is practically nontoxic to adult honey bees.

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